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The Cost-Benefit Analysis of Extending the Grazing Season in Beef Cattle Production in Atlantic Canada

Par

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Mémoire présenté à l'École de Gestion
En vue d'Obtention du grade de
Maître ès sciences, M. SC.

Programme de maîtrise en Économique

Abstract

Today, feeding cost is a significant issue for the financial viability of livestock systems, including beef cattle production. The aim of the study was to integrate economics, forage agronomy and livestock production data to determine the economic costs and benefits of management techniques that can extend the grazing season for beef production in Atlantic Canada. In turn, this information will allow the determination of the financial and/or economic value of extending the grazing season for an Atlantic beef farmer and for the whole Atlantic community.

The results of the study show that extending the grazing season is financially and economically beneficial for both an Atlantic beef farmer and the whole Atlantic community. It can contribute to avoiding expenses in the range of $3,646 to $14,704 per producer per year depending on the farm size characteristics. These expenses are avoided through eliminating and/or reducing the overwintering costs for feed, yardage and straw bedding. The study shows a saving of $0.92 in overwintering production costs per cow/calf per day. This means that, as the number of cattle days on pasture increases, the greater the reduction in production costs will be. Considering its direct and indirect advantages, extending the grazing season can procure an annual economic benefit in the range of $4,261 to $18,369 to an Atlantic beef producer and $5.43 million to $20.96 million for the whole Atlantic region depending on farm size characteristics. On a production horizon of 15 years, this economic benefit would be in range of $36,468 to $157,199 for an Atlantic beef farmer and $46.5 to $179.4 million for the whole Atlantic region community.

Extending the grazing season could be an alternative solution to enhance beef farm viability in Atlantic Canada and more globally in North America. Extending the grazing season can also contribute to the sustainable development of beef cattle production in Atlantic Canada through its benefits for environmental protection. The results of this study reflect the necessity of supporting and promoting the adoption of extended grazing season practices in Atlantic beef production. This support and this promotion could involve increasing awareness, training on grazing management skills, diffusion at workshops and participatory research.

Résumé

Aujourd'hui, le coût d'alimentation est un grand enjeu pour la viabilité financière des systèmes d'élevage dont l'élevage bovin. L'objectif de l'étude était d'intégrer l'économie, l'agronomie du fourrage et les données de la production du bétail pour déterminer les coûts et les avantages économiques des techniques de gestion qui prolongeraient la saison de pâture en élevage bovin en région Atlantique. La finalité de l'étude est de déterminer la valeur financière et/ou économique du prolongement de la saison de pâture pour un éleveur de bovin de l'Atlantique et pour l'ensemble de la région de l'Atlantique.

Les résultats de l'étude montrent que prolonger la saison de pâture est financièrement et économiquement bénéfique pour l'éleveur de bovins et pour la communauté de l'atlantique. Cette approche d'alimentation contribuerait à éviter des dépenses de l'ordre de 3 646$ à 14 704$ par éleveur et par an suivant la taille de l'exploitation. Ces dépenses sont évitées via l'élimination et/ou la réduction des frais hivernaux de conduite des animaux dont les frais d'alimentation, les frais généraux et les frais de la litière. Une analyse détaillée montre une économie de 0.92$ par couple bovin/veau par jour hivernal. Ce qui signifie que, plus le nombre de séjours des animaux sur le pâturage d'hiver augmente, plus les coûts de production diminuent. Considérant ses avantages directs et indirects, la pratique de prolongement de la saison de pâture procurerait un bénéfice économique annuel de 4 261$ à 18 369$ à un éleveur bovin de l'Atlantique et 5,43$ à 20,96$ million à l'ensemble de la région, suivant la taille de l'exploitation. Sur un horizon de 15 ans, ce bénéfice économique se situerait entre 36 468 $ et 157 199$ pour un éleveur bovin et entre 46,5$ et 179,4$ million pour l'ensemble de la région Atlantique.

Prolonger la saison de pâture pourrait être une solution alternative de renforcement de la viabilité des élevages bovins au Canada atlantique et plus globalement en Amérique du Nord. De plus, cette approche contribuerait au développement durable de l'élevage bovin grâce à ses avantages pour la protection de l'environnement. D'où la nécessité de soutenir et de promouvoir l'adoption de cette pratique en élevage bovin en région Atlantique. Ce soutien et cette promotion pourraient se faire via une meilleure sensibilisation, la formation sur la gestion du bétail au pâturage, les ateliers de diffusion et la recherche participative.

Acknowledgements

I would like here to express my sincere thanks:

To God, for all the blessings, health, strength and courage without which this work would not have occurred.

To AAFC-AAC, for providing me the funds to conduct this study through the Research Affiliate Program.

To my AAFC Supervisor, Holly MAYER. I am very grateful for her excellent guidance and help for the success of this study. I express her my perfect gratitude.

To my Supervisor from University of Sherbrooke, Professor Dorothée BUCANFUSO, to having accepted to supervise my research thesis and for the quality of her remarks and suggestions. I am very grateful.

To Professor Luc SAVARD, from University of Sherbrooke, for the reading and comments. Thanks.

To my Co-Supervisors from AAFC, Tanya DYKENS and John DUYNISVELD. Thanks for their availability and constant help along my research work. I express them my perfect recognition.

To Darren BRUHJELL, from AAFC Lacombe, for his collaboration with the project that allowed me to carry out this study. I express him my gratefulness.

To Jonathan WORT, from Perennia. Sincere thanks for his availability and his notable contribution for this study.

To Cedric MACLEOD, a beef specialist from New Brunswick, for his contribution to the realization of this study. Thanks.

To Professor Emmanuel YIRIDOE, from Dalhousie Agriculture Campus, for his comments and suggestions. Thanks.

To all my colleagues at AAFC Truro. Thanks for all these interesting moments.

To all the staff in the Department of Economics at University of Sherbrooke and my friend students. Thanks for these moments spent together.

To my parents and all my family, who have always assisted me and constantly expressed their affection. Thanks.

To my Lovely wife Gaële for her daily presence in my life. Thanks for all!

To my friend Abdoulaye. Thanks for your inestimable friendship.

To the province of Nova Scotia, and in particular the city of Truro. Thanks for the hospitality.

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Abbreviations

AAFC: Agriculture and Agri-Food Canada

BCS: Body Condition Score

BMP: Beneficial Management Practices

BW: Body Weight

CAD: Canadian Dollar

FAO: Food and Agricultural Organisation

GHG: Greenhouse Gases Emissions

IRR: Internal Rate of Return

LBs: Pound (Mass)

MIG: Management Intensive Grazing

NB: New Brunswick

NF: Newfoundland

NPV: Net Present Value

NRF: Nappan Research Farm

NS: Nova Scotia

OECD: Organisation for Economic Co-operation and Development

PEI: Prince Edward Island

RMP: Risk Management Program

SEK: Swedish krona (Swedish currency)

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Introduction

1. Background

In Canada, as in many developed countries, government support to agricultural production remains one part of farmers' income. The European Commission (2015), from 2010 to 2013, indicates that when all subsidies are taken into account, total public support to agricultural income reached 40% of agricultural income on average in the EU-27. In Canada, the same problem appears and one reason for this may be the incapacity of livestock systems to be financially autonomous and could be due to low return on investment in a context of high operational production costs, including feed cost (Lachapelle, 2014). This situation would not be necessarily the same in developing countries due to low agricultural labour cost. Globally the labour cost in the agriculture sector is generally lower in comparison to other production sectors, this gap is relatively more pronounced in developing countries (Gollin *et al.,* 2014).

In general, animal feed represents the largest input cost for livestock and poultry producers, up to 75 percent of the total cost, depending on species. The use of production systems with lower feeding costs could thus contribute to improving the profitability of livestock farming. Particularly in beef production, some studies conducted in western Canada have shown that innovative feeding strategies under the general description of "extending the grazing season" can be an alternative solution to enhance beef farm viability (McCartney *et al.*, 2004; Kaliel, 2004; Baron *et al.,* 2014).

According to D'Souza *et al.* (1990), extending the grazing season is a management system in which the usual grazing season is lengthened by the utilization of hay fields for pasture. It may also consist of utilizing the stock of perennial forages (Peterson *et al.*, 2001). In fact, in regions where there are winter conditions, as in Canada, diverse strategies or methods exist to extend the grazing season and reduce the overwintering production costs in ruminant production (Baron *et al.*, 2014; D'Souza *et al.*, 1990; Peterson *et al., 2001;* Lemaire and Pflimlin, 2007).

In the USA, stockpiled forage is often used to extend the grazing season as it is considered the most economic strategy to feed animals during winter and reduce production costs (Peterson *et al.*, 2001; Thomas, 2014). According to Peterson *et al.* (2001), one of the best methods to extend the grazing season through fall, and possibly even into early winter in some areas and years, is the stockpiling of perennial forages. For Thomas (2014), extending the grazing season can include stockpiling, seeding, livestock management, by-products, cover crops and residue grazing.

In Northwest Europe, including France, extending the grazing season is used as a strategy to reduce production costs and address some uncertainties in the production environment such as high corn prices, recurrent drought episodes and the increase in farm size (Lemaire and Pflimlin, 2007; Pottier *et al.*, 2009). Extending the grazing season for ruminant production in Europe also aims to preserve the environment, respond to consumer demand and conform to the present context of progressive de-intensification of production systems (Pottier *et al.*, 2009).

In Canada, many research studies have been done related to grasslands and how they can be better utilized for cattle feeding[1]. Particularly in western Canada, research studies focused on beef feeding strategies are trying to determine how beef cattle can be raised more economically and sustainably by reducing their production costs and environmental impacts (Kaliel, 2004; Baron *et al.*, 2014; Baron and McCartney, 2014a; Government of Manitoba, 2008a). These studies attest to the role that extended grazing season approaches can play in reducing beef production costs. However, extended grazing season approaches are used less in Atlantic beef production, where farmers continue to employ a conventional feeding approach which consists of raising animals on pasture during summer and feeding them in the barn the reminder of the year. Beef and forage researchers are currently conducting research on extending the grazing season in Atlantic beef production, taking into account the unique weather conditions in the region. This thesis contributes to this extended grazing scientific research by analysing the economic costs and benefits of management techniques that can extend the grazing season for beef cattle production in Atlantic Canada.

[1] http://www.foragebeef.ca/app33/foragebeef/index_body.jsp

2. Economic Problem

Feed costs are a significant issue for the economic viability of livestock systems, including beef cattle production. An economic analysis of production costs associated with cow/calf enterprises shows that, across Alberta, the share of feed, bedding and pasture costs averaged 60% of total production costs with the winter feed component alone averaging 32% of total production costs (Kaliel, 2004). This does not include additional costs associated with feed delivery systems employed throughout the winter feeding period, which could lead to a sharp increase in winter feeding costs. These additional costs include cost of harvesting, hauling, feeding and manure removal. Eliminating or reducing these costs by extending the grazing season can reduce the costs of winter feeding for beef farmers by 40% (McCartney *et al.*, 2004). The Atlantic Canada region as a whole could also indirectly benefit from extending the grazing season through other services provided by grassland systems such as environmental preservation and recreation functions (Boval and Dixon, 2012).

However, extending the grazing season also requires good skills in grazing management, as well as the capacity to manage uncertainties with the weather conditions. This situation may result in additional costs to farmers. The analysis of real benefits and costs associated with the extended grazing season approach could help Atlantic beef farmers who would like to adopt this approach. This study will help farmers in their decision by providing the economic analysis. Furthermore, the results of this study will help guide policy makers in supporting sustainable beef cattle production in Atlantic Canada.

3. *Research Problem*

In Atlantic Canada, the use of innovative feeding approaches in beef production, such as extending the grazing season, is still limited. According to some Atlantic beef specialists, some reasons would be that many Atlantic beef farmers are too attached to conventional practices and some believe that new practices could not work. They also believe that it is essential to have a barn for cattle and do not believe in leaving animals outside during winter. The lack of good skills in grazing management as well as the necessity to manage uncertainties with weather conditions could be other limits. Indeed, with snow and frequent rains during winter, as it is the case in the Atlantic region, raising animals on pasture without best management strategies to deal with the weather could result in significant wastage and reduce animal grazing days per land area (Baron and McCartney, 2014a). However, farmers can overcome this problem through improved management approaches and practices. They could also identify, through existing approaches to extend the grazing season, the appropriate techniques for their production system, given their unique weather conditions.

In summary, studies have shown that extending the grazing season could be a good way to enhance beef farm viability; as it can eliminate storage, manure removal and spreading costs, reduce use of tractors, reduce labour costs for animal feeding and improve soil fertility (McCartney *et al.*, 2004; Alberta Agricultural Food and Rural Development, 2004; Wort, 2013). Therefore, this study will attempt to determine appropriate techniques for extending the grazing season in Atlantic beef production given all different constraints in the study area.

4. *Purpose and Objectives of the Study*

The aim of the study is to integrate economic, forage agronomy and livestock production data to determine the economic costs and benefits of management techniques that can extend the grazing season in beef cattle production in Atlantic Canada. The specific objectives are:

a) Identify appropriate extended grazing season approaches for Atlantic beef production. In fact, due to the unique weather conditions in the Atlantic region, successfully extending the grazing season could be dependent on the choice of appropriate management techniques.

b) Understand the conventional feeding approach in Atlantic Canada. In order to determine the financial and economic value of extending the grazing season in Atlantic beef production, the understanding and description of the common beef feeding approach in the area is necessary.

c) Analyse and determine the most efficient feeding system. The economic analysis of the extended grazing season feeding system, in comparison to the conventional feeding system, will help to determine the most efficient system for the Atlantic beef farmer and for the whole Atlantic region.

5. Outline of Thesis

After the introduction, the remainder of the study is organised in two main parts with seven chapters.

The first part focuses on grassland systems and different grazing management strategies used to valorise them for animal feed. This first part, described in chapters one and two, gives a general overview of the worldwide importance of grassland systems, including their use for livestock production.

The second part of the study is subdivided in five chapters, from chapter three to chapter seven. Chapter three presents the research methodology and the theoretical basis of the approach of cost-benefit analysis. Chapter four focuses on the financial analysis of extending the grazing season in Atlantic beef production. The analytical approach, data compilation and results are presented. Chapter five is devoted to the quantification of costs and benefits associated with the extended grazing season project in beef production in Atlantic Canada. For this purpose, the protocol of cost-benefit analysis is applied to the project, with the conventional feeding system in the study area as the benchmark. Chapter six considers the variability of farm size in Atlantic region, in addition to the most realistic project impacts, to evaluate the robustness of the project outcomes using alternative scenarios. The last chapter, seven, is devoted to the general summary of findings and conclusions.

Part I:

Grassland Systems and Grazing Management Strategies

Chapter 1. Importance of Grassland Systems

According to Steinfeld *et al.* (2006), grasslands occupy 26% of the total land area in the world; and livestock production accounts for 30% of the total land surface of the planet. Grasslands, including rangelands, shrub land, pasture land and cropland sown with pasture, trees and fodder crops represents 70 percent of the world's agricultural area (Conant, 2010).

These vast grassland systems throughout the world gives an overview of their worldwide importance, and particularly their importance for livestock production. In fact, grasslands are of great importance to our planet, including their use for livestock production, for environmental and land management, and for their economic and cultural benefits.

1.1. Role of Grasslands for Livestock Production

Grassland management systems are plans utilized by livestock producers to coordinate plant and animal growth and productivity during the pasture season (Papadopoulos *et al.*, 1993). Forage is the main feed for ruminants due to their physiology and anatomic predispositions. Grasslands are very important, as they are the basis of ruminant feed supplies. According to Carlier *et al.* (2009), in many countries of the world, pastoral rangelands are the primary, and only resource, on which both wild and domesticated herbivores depend. In Western Canada, forage production is the foundation of beef cattle production and approximately 80 per cent of Canada's beef production occurs while animals consume forage (Saskatchewan Forage Council, 2011). In Atlantic Canada, pasture is probably the main advantage of ruminant livestock enterprises (Papadopoulos *et al.*, 1993). In 2011, approximately 114 000 ha were used as pastures in Atlantic Canada (Table 1) (Statistics Canada, Table 004-0203); which is an increase in pasture use, as only 80 000 ha were used in 1991 (Papadopoulos *et al.*, 1993).

Table 1 Census area of total, cropped and pasture land in the Atlantic Provinces in 2011 (thousand hectares)

	NS	**PEI**	**NB**	**NF**	**Atlantic Provinces**
Total land	5 284	566	7 157	37 164	50 171
Cropped land	113.67	166.21	142.14	8.34	430.36
Pasture land	46.30	17.73	39.72	10.21	113.96

Source. Own elaboration adapted from statistics Canada (2011, Table 004-0203)

Grazing ruminants on grasslands also provides the unique advantage of converting otherwise indigestible cellulose-rich plant material into meat, milk, wool and leather, whilst not competing directly with humans for other food (Buddle *et al.*, 2011; Beauchemin *et al.*, 2010). Today, increasing population growth leads to increasing global demand for meat and milk, which also necessitates increasing the level of production. This increase in production is possible through increasing the voluntary intake and/or the digestibility of diets selected by grazing animals (Boval and Dixon, 2012).

Raising animals on pasture is also interesting in terms of animal welfare compared to the confinement feeding system (Gerlach, 2014). Indeed, raising animals on pasture, which is very close to the free range system referred to as an "animalfriendly system", is recognized as an important component of animal welfare and health (Martelli, 2009; Harper and Makatouni, 2002). A study carried out by Gerlach (2014) at Kansas State University, on the effects of exercise on beef cattle health, performance and carcass quality, shows that high concentrate diets and sedentary lifestyles in the confinement system generally lead to poor animal welfare and health due to insulin-resistance. Grazing could help improve the physical fitness of cows (Fredeen *et al.*, 2002).

Moreover, with good grazing management practices, animal products coming from grasslands husbandry are more likely to be of high-quality. Indeed, according to Boval and Dixon (2012), apart from low-cost production of animal products, grasslands offer opportunities to produce high-quality foods with higher market value than similar products derived from intensive livestock production. Therefore, in addition to their role in providing basic nutrients for herbivores and ruminants, grassland systems have opportunities to add value by exploiting positive health characteristics in animal products (Carlier *et al.*, 2009; McAfee *et al.*, 2011; Gerlach, 2014).

In sum, the sustainability concept, which aims to satisfy the present generation without compromising future generations, requires the development of production systems quantitatively and qualitatively efficient, and respectful of environment. Livestock production based on grassland systems are more likely to be sustainable than concentrated feed-based systems. Moreover, the importance of grasslands goes beyond livestock benefits, as they can play many other roles which could benefit society.

1.2. Other Roles of Grasslands

Besides their importance for ruminant production, grassland systems also have environmental, economic and cultural benefits.

The environmental roles of grassland systems include, among others, contribution to the protection and conservation of soil and water resources, habitat for wildlife and biodiversity preservation (Carlier *et al.*, 2009; Rothwell, 2005; Beauchemin *et al.*, 2010; Yungblut, 2012; Vaisey and Strankman, 1999). Grasslands could also contribute to reducing global warming by directly or indirectly reducing the environmental impact of greenhouse gas emissions (GHG) (O'Mara, 2012). Studies quantifying GHG emissions from beef production show that most GHG emissions come from pasture-based systems due to low enteric emission from feedlot systems (Vergé *et al.*, 2008; Beauchemin *et al.*, 2010). However, by taking into account the carbon sequestration of grassland systems, it indicates that pasture-based systems provide more GHG mitigation compared to feedlot systems (Lee and Carson, 2015; O'Mara, 2012). According to O'Mara (2012), the carbon stored in global grasslands is more important than in global forests. In addition, given the other multiple services of grassland systems such as habitat for wildlife, recreation services, landscape maintenance and environmental protection (Boval and Dixon, 2012; Conant, 2010), the pasture-based system appears to be the most sustainable production system compared to a feedlot system (Beauchemin *et al.*, 2010; O'Mara, 2012).

From an economic point of view, the importance of grasslands is generally difficult to quantify. In addition to their direct use values, such as ecotourism and livestock feed, the non-use values of grasslands often outweigh the values of conventional uses (Gössling, 1999; Yungblut, 2012). According to Boval and Dixon (2012), in developing countries grasslands are particularly important to the livelihoods of some one billion underprivileged people. They have a significant contribution to food security by providing part of the feed requirements of ruminants used for meat and milk production (O'Mara, 2012; Buddle *et al.*, 2011). Furthermore, grassland systems contribute to reducing ruminants' feed costs (Kaliel, 2004; D'Souza, 1990; McCartney *et al.*, 2004; Baron *et al.,* 2014). In Canada, the global value of grasslands is very important and classified into direct and indirect values (Yungblut, 2012). The direct values are generated through economic activities associated with a wide variety of sectors such as ecotourism and livestock feed; while indirect values are generated by ecological goods and services such as erosion control, flood control, water quality, wildlife habitat, pollination services and carbon sequestration (Saskatchewan Forage Council, 2010). Today, with the use and continuous depletion of renewable fuels, some grassland ecosystem species such as poplar, willow, and perennial grass species including miscanthus and wheat straw are recognized as energy crops for second generation biofuels (Carlier *et al.*, 2009).

In addition to their economic and environmental roles**,** grasslands can also play other unquantifiable roles in our society. These other unquantifiable roles include cultural heritage or people identity (Fraser and Chisholm, 2000), aesthetic, human recreation and amenity (Saskatchewan Forage Council, 2010).

1.3. Summary

This chapter has given an overview of the importance of grassland systems. It shows that grassland systems play an importance to the planet in a wide variety of ways, including animal production, environmental and land management, economic and cultural benefits. The forages furnished by grassland systems are at the basis of ruminant feed supplies by reason of the physiological and anatomical predispositions of these animals. This importance of grassland systems reflects the necessity to manage them in a good way, to provide a better utilization for livestock production.

Chapter 2. Grazing Management in Canada

This chapter deals with grazing management practices and strategies used in Canada. It also discusses the unique weather conditions in the Atlantic region, which could impact the choice of appropriate grazing system.

2.1. Benefits of Grazing Management in Livestock Production

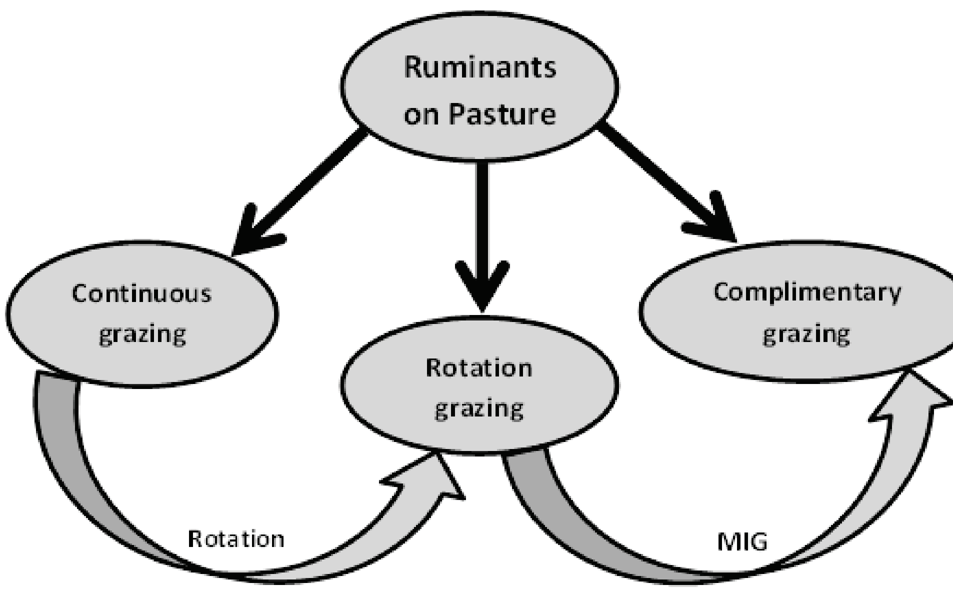
There is a necessity to ensure best practices in livestock production in order to minimize environmental impacts and reduce production costs.

Minimizing environmental impacts of livestock production could involve the adoption of beneficial management practices (BMPs), which are farm production or management practices designed to reduce environmental risks of farming systems (Rothwell, 2005).

Reducing production costs is possible through reduction of feed costs by using integrated grazing strategies. These integrated strategies can be summarized in two mains objectives of grazing management (Manitoba Forage Council, 2006). The first objective is to control grazing animals, provide rest and recovery time for the plants, extend the life of the most productive plant species in the pasture, keep the plants in a vegetative state and improve their nutritional value. The second objective is to improve the soil fertility by growing nitrogen fixing legumes and recycling crop residues, and to lower the production cost by extending the grazing season.

Many studies have shown the economic (Vaisey and Strankman, 1999; Van den pol-van Dasselaar *et al.*, 2014; Pottier *et al.*, 2009; Yungblut, 2012) and environmental (Conant, 2010; Yungblut, 2012; Carlier *et al.*, 2009; Vaisey and Strankman, 1999; Haak, 2011) benefits of cattle pasture-based systems compared to confinement-based systems.

However, pasture-based systems imply advanced planning and establishment of the appropriate method and strategy (Singh, 2012). Several grazing methods are generally used by beef farmers. Manitoba Forage Council (2006), suggests the three most common grazing methods are continuous grazing, rotational grazing and complimentary or management intensive grazing (MIG) (Figure 1).



Source. Own elaboration

Figure 1. Grazing methods for ruminant production in Canada

Continuous grazing requires a low level of management; however, it results in the repeated grazing of new growth, which could reduce plant productivity. Rotational grazing provides an opportunity for plants to rest and recover; however, it requires more inputs in terms of fences and labour. The last one, complimentary grazing or MIG, is a type of rotational grazing. The key difference is that MIG uses a combination of native land and seeded land to emphasize on the growing potential of the forages, its quality and its consumption by the animals.

2.2. Methods of Extending the Grazing Season

In addition to different grazing methods, the other challenge for forage and beef specialists is how to allow more cattle days on pasture given the economic and environmental advantages offered by grassland systems. This leads to the general concept of "extending the grazing season" presented in the following section.

Extending the grazing season is a management system in which the usual grazing season is lengthened by the utilization of hay fields for pasture (D'Souza *et al.*, 1990) and/or the use of the stockpiling of perennial forages (Peterson *et al.*, 2001). Grassland systems are economically advantageous for raising beef cattle. In fact, extending the grazing season in beef cattle production can reduce the total annual feed and feeding costs compared to the use of conserved feed in the barn (Baron and McCartney, 2014a; McCartney *et al.*, 2008). In Western Canada, the winter feed cost may account for up to 60 - 65 % of total annual feeding costs (Kaliel and Kotowich, 2002). According to the maritime pasture manual (Perennia, 2010), overwintering may account for 60 - 80% of total annual production costs on conventional beef and sheep farms in Atlantic Canada. By reducing overwintering production costs, extending the grazing season can contribute to enhancing beef farm financial viability in Atlantic Canada.

Extending the grazing season increases the number of days that animals are fed on pasture and reduces the number of feeding days in the barn. This approach requires the herd manager to take some early actions to identify and plan the appropriate strategies (Singh, 2012); it cannot be an impulsive decision to leave the animals grazing for a longer period of time. In Canada, the different strategies to extend the grazing season can be grouped under three main methods: stockpiled grazing, swath grazing and bale grazing.

2.2.1. Stockpiled Grazing

Source. Government of Manitoba (2008a)
Figure 2. Stockpiled spring transition forage

Stockpiled grazing (Figure 2) is summer forage regrowth which is saved for use as fall and winter pasture. It may replace part or all of the hay, straw or silage needed for winter feeding beef cattle and can be an important part of a cattle producer's production system (Baron and McCartney, 2014a). The stockpiled grazing method requires very low inputs through the elimination of costs related to harvesting of hay, and reduced labour for feeding and manure handling. Stockpiled grazing is economically interesting in the sense that animals feed themselves and spread manure themselves, which results in a considerable savings on labour and machinery costs (Hamilton, 2012). However, the use of the stockpiled grazing method is limited in time, in the sense that it is not beneficial to stockpile the forage for a long period before the animals consume it. Indeed, if left for a long time before grazing, the stockpiled forage loses its nutritive quality in response to growth and emergence of fibrous elements (Perennia, 2010), and in response to rain and snowfall during winter. Stockpiled grazing presents benefits in Atlantic Canada as a method to extend the grazing season at low cost, in a part of the year where rain and snowfall are not very frequent, usually from mid-autumn to early winter.

2.2.2. Swath Grazing

Source. Alberta Agriculture Food and Rural Development (2004)
Figure 3. Grazing down swaths and swath grazing through snow

Swath grazing (Figure 3) is another management practice that can be used to extend the grazing season and reduce feed, labour and manure handling costs for cattle producers (Alberta Agricultural Food and Rural Development, 2004). Swath grazing is practiced more commonly in Western Canada, where it is considered the main method to extend the grazing season and reduce cattle overwintering costs (Baron *et al.*, 2014; Baron *et al.*, 2012; Alberta Agricultural Food and Rural Development, 2004). However, weathering caused by late fall and winter precipitation, in conjunction with snowmelt, can reduce the nutritive value of swathed material substantially (Aasen *et al.*, 2004). For this reason, in Atlantic Canada, where rains are very common during autumn and winter, swath grazing is less appropriate as a technique to extend the grazing season.

2.2.3. Bale Grazing

Source. Government of Saskatchewan (2012)

Figure 4. Bale grazing

Bale grazing (Figure 4) is the practice of placing large quantities of bales out for livestock in the fall and regulating access to the bales and intake in the winter using electric wire fencing (Government of Manitoba, 2008a). It is also called extensive bale grazing, in contrast to intensive bale grazing which corresponds to feeding animals with baled forage on a confined area (Government of Saskatchewan, 2012). As swath grazing appears to be the main method of extending the grazing season in Western Canada by reason of its productivity and nutritive value (Baron *et al.*, 2014), bale grazing seems to be the method of choice for extending the grazing season in the Atlantic region. Indeed, in Atlantic Canada, bale grazing has the most benefits as it is mostlikely to maintain the feed nutritive value during winter.

2.3. Management Considerations for Extending the Grazing Season

Considering the unique weather conditions in the Atlantic region, the relative benefits of the three methods of extending the grazing season can be summarized in Table 2. In general, the stockpiled grazing method is the one which requires the least inputs among the three methods, while bale grazing requires the most inputs. Compared to swath grazing, bale grazing requires more inputs due to bale handling, during both harvest and feeding. However, the most economical method is swath grazing due to its high productivity level, followed by stockpiled grazing due to its very low input requirement.

Table 2 Benefits of extended grazing season methods in Atlantic Canada

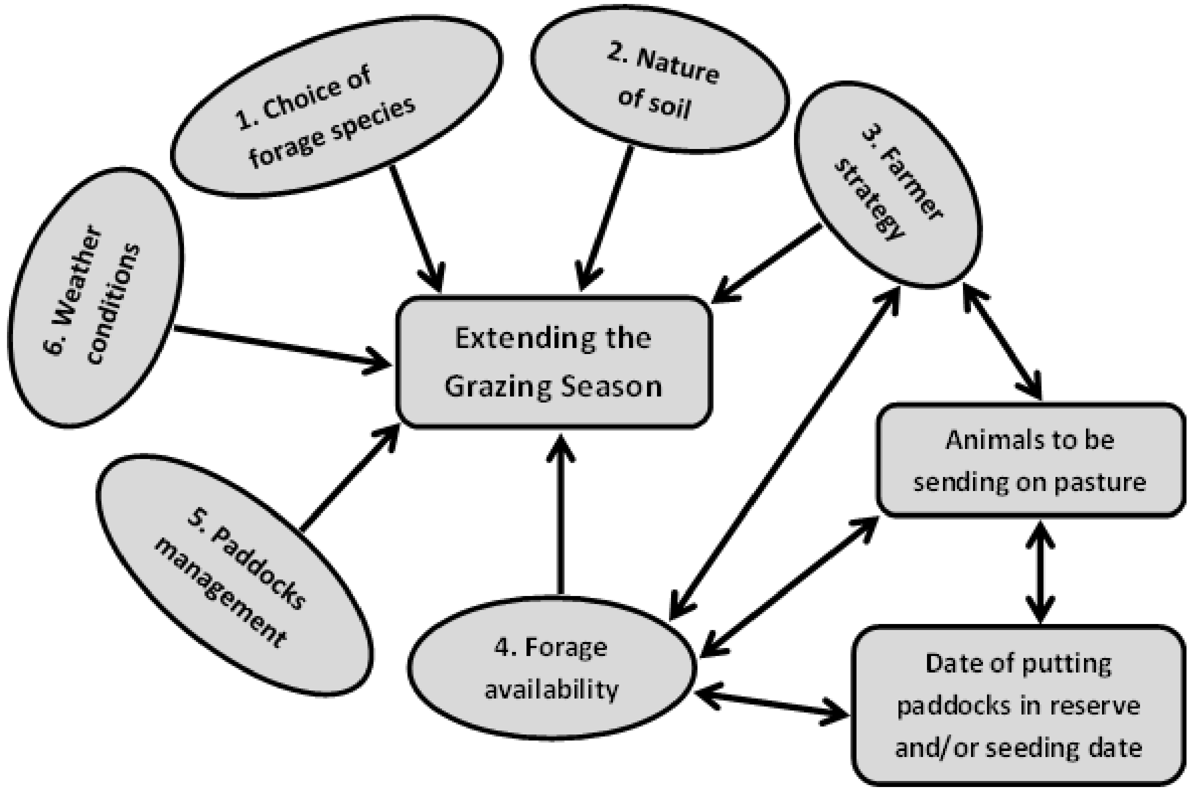
Stockpiled grazing			**Swath grazing**			**Bale Grazing**		
Inputs	**Productivity**	**Nutritive value**	**Inputs**	**Productivity**	**Nutritive value**	**Inputs**	**Productivity**	**Nutritive value**
+	++	++	++	+++	++	+++	++	+++

Source. Own elaboration + = Low; ++ = Medium; +++ = Higher

Bale grazing and stockpiled grazing have complementary benefits in Atlantic Canada. Bale grazing is mostly likely to provide feed with good nutritive value to the animals, while stockpiled grazing's main benefit is its lower cost during mid-autumn to early winter. The combination of these two extended grazing approaches appears to be a good technique to extend the grazing season in Atlantic Canada.

In sum, the choice of a method to extend the grazing season depends heavily on the objectives and strategies planned by the farmer and on the geographic characteristics of the region. According to Manitoba Forage Council (2012), the successful implementation of an extended grazing season method is highly dependent on climatic factors, in particular the precipitation; and these factors are subject to considerable year-to-year variation. The importance and contribution of a method to extend the grazing season depends on many factors which need to be taken into account. The strategies and approaches also need to be thought out and developed well in advance of the season of implementation (Singh, 2012).

In general, the management considerations for extending the grazing season must take into consideration many factors (Figure 5), including: the choice of forage species (Government of Manitoba, 2008a; Baron and McCartney, 2014b); the nature and properties of soil (Haak, 2011); the choice of seeding date or the time to put paddocks in reserve (Kunelius *et al.*, 1987; Cuomo *et al.*, 2012; Baron *et al.*, 2012); the possibilities of mixed varieties to improve forage quality and availability (Pottier *et al.*, 2001; Weigelt *et al.,* 2009); the paddocks and land management over time (Volesky *et al.*, 2002; Haak, 2011); the role of the technical manager (Volesky *et al.*, 2002); the management and consideration of weather conditions (Baron and McCartney, 2014a); as well as the type and physiological status of animals.



Source. Own elaboration
Figure 5. Extending the grazing season and influencing factors

2.3.1. Choice of Forage Species

The choice of forage species is an important consideration for the extended grazing season strategy. In fact, some species could be appropriate for one extended grazing season method and not for others. Depending on the forage species, stockpiled grasses and legumes could be grazed as standing crops or could be used in swath grazing (Government of Manitoba, 2008a). The stockpiled grazing method involves the choice of forage species which are able to resist, stand upright and lose less materials through rain and snow during fall and winter, such as tall fescue (Barnhart, 2010); while swath grazing depends essentially on choosing forage species with low loss of nutritive value. This choice of plant species is also correlated to the yield and the growth rate. For example, barley, which quickly reaches the soft dough stage, produces a lower yield; while triticale, which takes more growing days to reach the soft dough stage, potentially produces more yield (Baron and McCartney, 2014b). All these characteristics need to be taken into account when considering each method to extend the grazing season.

2.3.2. Nature of Soil

The nature of soil needs to be taken into consideration when looking at strategies for extending the grazing season. For better grazing management, it is important to consider the soil fertility level in order to limit the environmental impact of livestock. For example, with the bale grazing method, it is best to choose soils with lower fertility in order to limit excess nutrients, which could be a source of environmental pollution (Haak, 2011; Government of Manitoba, 2008b). The bale grazing site should be on lower sloped land and far from watercourses in order to limit water pollution by nutrients lost through flow of surface waters during winter (Haak, 2011).

2.3.3. Farmer Strategy

The farmer strategy to extend the grazing season, in conjunction with other factors, could influence the choice of date to put paddocks in reserve or the seeding date (Kunelius *et al.*, 1987). For example, if the farmer would like to use the stockpiled forage to feed dry cows during winter, the strategy would be to maximize on forage quantity. In contrast, if the farmer plans to use the stockpiled forage for calves, the goal would be to maximize the nutritive value of forages rather than the quantity. This maximization of forage quantity or quality could be attained through the choice of forage species and the date of seeding or setting paddocks in reserve (Cuomo *et al.*, 2012; Baron *et al.*, 2012). iIt is also important to note that increasing forage yield and quality do not generally go together, as the strategy which increases yield generally decreases quality and vice versa (Kunelius *et al.*, 1987; Baron *et al.*, 2012). The choice to maximize on quantity or on quality of forage also reflects the importance of taking into account the animals' physiological status when choosing a strategy to extend the grazing season.

2.3.4. Forage Availability

Extending the grazing season requires the forage availability in both quantity and quality, in order to satisfy animals' requirements and production goals. To attain these objectives, the possibility of mixed species could be one solution to improve forage availability. According to Pottier *et al.* (2001), the practice of low loading and the use of a diversity of species of forage plants are considerable assets to meet animals' requirements and various production goals. Weigelt *et al.* (2009) have also shown that higher grassland diversity increases productivity more than higher management intensity.

2.3.5. Paddock Management

Paddock management is also important for the success of extended grazing season approaches. The lack of good management of paddocks can lead to increased forage waste (Volesky *et al.*, 2002) and to an excess of nutrients in the environment, due to the heterogeneous distribution of manure (Haak, 2011). This situation, which could lead to environmental pollution, explains the role that the manager plays in the successful implementation of the extended grazing season method (Volesky *et al.*, 2002).

2.3.6. Management of Weather Conditions

The weather conditions constitute an important factor to be taken into consideration when choosing strategies to extend the grazing season. The weather conditions generate uncertainties which could limit the efficient capitalization of pasture for cattle production. Indeed, in areas with high snow fall or icy conditions, animals will have difficulty grazing all of the available forage regrowth, leaving areas that are incompletely grazed, resulting in significant wastage and reduced animal grazing days per land area (Baron and McCartney, 2014a). This situation reflects the necessity for farmers to have good grazing management skills. It also reflects the necessity to consider providing field shelters, such as windbreaks, to accommodate animals during hard weather conditions.

2.4. Weaknesses of Extending the Grazing Season

Extending the grazing season for ruminant livestock production presents a lot of strengths, including economic benefits, animal welfare, manure management and environmental protection.

However, extending the grazing season in ruminant production may also have some weaknesses, mainly in terms of risk with weather conditions (Hamilton, 2012). Frequent rain and snowfall may result in the loss of nutritive value of forage crops and create further uncertainties regarding the herd management. Under this situation, raising animals outside during winter without a good management strategy could lead to muddy conditions, which increases labour requirements and brings difficulties in herd management. Nevertheless, these limits, attributed to poor management strategy, could be overcome by proper planning and improving the management practices of grazing animals during winter.

In sum, extending the grazing season could present a lot of benefits for Atlantic beef production. Table 3 summarizes the strengths and weaknesses of extending the grazing season, in comparison to the conventional feeding practices for beef production in Atlantic Canada. The conventional feeding practices refer to the most common feeding approach followed by Atlantic beef farmers, which is based more on confinement systems. With this common feeding approach animals are generally on pasture during summer and in the barn the rest of the year.

Table 3 Extending the grazing season versus conventional beef feeding practices in Atlantic Canada

Extending the Grazing Season		Conventional Feeding Practices	
Strengths	**weaknesses**	**Strengths**	**weaknesses**
Reduces production costs	Risk with weather conditions	Less uncertainties with weather conditions	Expensive
Animal welfare	Requires good management skills		Problem of animal welfare and negative perceptions of livestock with society
Good manure management and soil fertility			Poor manure management and soil fertility
Less environmental impact			Environmental impact
Products with a better quality			Products with a lower quality

Source. Own elaboration

2.5. Summary

This chapter was devoted to grazing management and the different methods and strategies to extend the grazing season for ruminant livestock production in Canada. The three main methods of extending the grazing season in Canada are stockpiled grazing, swath grazing and bale grazing. Swath grazing is the common method used to extend the grazing season in beef cattle production in western Canada. Bale grazing and stockpiled grazing appear to be the best combination of approaches to extend the grazing season in Atlantic beef production. Extending the grazing season in Atlantic beef production has a lot of strengths by the role that it could play in the reduction of production costs, the improvement of animal welfare and environmental protection.

However, in order to determine the real possible contribution of extended grazing season approaches for beef farm viability in Atlantic Canada, it would be appropriate to conduct an economic study. This economic study will highlight both the advantages and limits of an extending the grazing season feeding system, in comparison to the conventional feeding system in the study area. This economic analysis would help to determine the most efficient feeding plan for the Atlantic beef farmer, as well as for the Atlantic region as a whole. Therefore, the remainder of this study will aim to determine the financial and/or economic value of extending the grazing season for an Atlantic beef producer and for the whole Atlantic community.

PART II:

Extending the Grazing Season and Beef Farm Viability in Atlantic Canada: The Cost-Benefit Analysis

Chapter 3. Research Methodology

The research methodology is based on the cost-benefit analysis approach with two separate components, financial and economic. The financial component consists of a partial modeling of farm production costs for two feeding plans: the extended grazing season feeding plan and the conventional feeding plan. The economic component goes beyond the financial analysis by quantifying the economic costs and benefits of the extended grazing season project, compared to the conventional feeding plan in the study area as the benchmark.

The conventional feeding plan corresponds to the common feeding management practices followed by beef farmers in the region. With this feeding plan, animals are raised on pasture during summer and in the barn during fall and winter. The extended grazing season feeding plan corresponds to a plan where animals are raised on pasture during the entire year using stockpiled and baled forage in the fall and winter. The choice of stockpiled and bale grazing comes from the conclusions of the first part of the study which indicate that stockpiled and bale grazing would be the best combined approach to extend the grazing season in Atlantic beef production.

3.1. Choice of Research Methodology

The choice of the research methodology is based on the wish to take into consideration the many questions which appear as challenge for the sustainable development of Atlantic beef production. The cost-benefit approach, through its double components, financial and economic, is a useful method to evaluate and determine what feeding system can contribute the most to farmers' income and to the sustainable development of the Atlantic region.

Other methods or approaches could also be used for this economic analysis. Including the econometric approach, the experimental approach and other approaches of economic evaluation, such as method of effects or method of impacts assessment. The econometric approach requires the existence of sufficient data from the study site, which is not the case for this study. The experimental approach would require a long period of experimentation with two groups of animals, one group following the common feeding system and another group following the extended grazing season feeding approach. This assumes that experiments have been carried out before the study, which it is not the case here. Other economic analysis approaches such as method of effects or method of impact assessment would be useful for the study. However, the cost-benefit approach is more likely to be used as it goes beyond simple quantification of project effects or impacts by taking into account all costs and benefits associated with the new method. The cost-benefit approach can help identify which situation is the most advantageous for a group of stakeholders and/or for a community. Through the cost-benefit approach, it will be possible to take into consideration the problem of Canadian farm viability, environmental issues, animal welfare, food quality concerns and the negative perceptions of livestock production by society.

Most of all, the question of sustainable development and the necessity to take into account in each community action, leads to the cost-benefit analysis approach as an excellent method for project evaluation. It has become one of the reference evaluation methods of many public institutions and development agencies such as OECD (Pearce *et al.*, 2006), Government of Canada (2007), USA (Rezki, 2008; Oustani *et al.*, 2009), European Commission (2006), FAO (2002). In Canada, since November 1999, the Federal Government has instituted a policy requiring the use of a cost-benefit analysis for all significant regulatory proposals to assess their likely impact on the environment, employees, businesses, consumers and other sectors of society (Government of Canada, 2007).

Finally, given the fact that this is an exploratory study on the possible benefits of extended grazing season practices in Atlantic beef production, the use of a cost-benefit approach appears relevant. The cost-benefit approach will help to identify all possible advantages and limits of this innovative feeding system, in comparison to the conventional feeding system in the study area. Knowing these advantages and limits would help Atlantic beef farmers in their decision on the adoption of extended grazing season practices in their production system.

3.2. Study Context and Physical Characteristics of Atlantic Canada

The aim of the study is to integrate economics, forage agronomy and livestock production data to determine the economic costs and benefits of management techniques that can extend the grazing season in Atlantic beef production. The problem of Canadian farm viability, the environmental issues, as well as the animal welfare are some questions which justify this present study. The study was done from mid-2015 to mid-2016 at the Truro, Nova Scotia office of Agriculture and Agri-Food Canada, with frequent field trips to the Nappan Research Farm (NRF), in Nappan, Nova Scotia.

The physical characteristics description of the Atlantic Provinces of Canada is provided by Butler *et al.* (1993). According to these authors, the Atlantic Provinces are particularly well adapted to the production of forage crops in reason of moderate temperatures and abundant rainfall, which is well distributed throughout the growing season. In addition to some physical constraints, soils are generally low in natural fertility, but respond well to applications of lime and fertilizer and conditioning. For Butler *et al.* (1993), while the region's cool and humid climate favours growth and production of forage crops, it also causes problems in their harvesting and utilization. The weather conditions, with high levels of humidity and relatively low temperatures make hay drying difficult. The seasonal growth patterns result in reduced production after early summer and make pasture management crucial; and the short growing season leads to increased reliance on conserved forages. Furthermore, the high rainfall pattern may promote heavy infestation of gastrointestinal parasites on grazing livestock.

3.3. Theoretical Bases of Projects' Evaluation Using Cost-Benefit Analysis

Different approaches are generally used for project and public policy evaluation. However, whatever the approach, the main aim of evaluation is to achieve the objectives at lower financial or economic costs (efficiency objective). The cost-benefit analysis is one of the most common methods of project and public policy evaluation.

3.3.1 Economic Versus Financial Evaluation of Projects

The financial evaluation is a component of economic evaluation and it is generally limited to small private projects. In fact, when it concerns public projects or big private projects, the economic evaluation become inevitable. The economic evaluation goes beyond of the financial evaluation by taking into account all positive and negative impacts of the new project at the scale of the community, which is the main goal of public projects and policies. For a big private project, the necessity to take into consideration the project impact on the other agents in the society becomes crucial for the project validation. The objectives and evaluation criteria for financial and economic evaluation are described in Table 4.

Table 4 Objectives and criteria for financial and economic evaluation

	Objectives	Criteria
Financial Evaluation	Quantify financial results of the new project for direct stakeholders.	**Monetary**: financial benefits coming from different operations of investment.
Economic Evaluation	Quantify sustainable results of the new project for direct and indirect agents at the scale of the community.	**Monetary**: net surplus for different stakeholders; **And non-monetary**: positive and negative impacts for the other agents at the scale of the community.

Source. Adapted from Garrabé (2013)

For public projects, if positive impacts are superiors to negative impacts, the project is qualified as viable (feasible), whatever the financial result. For big private projects, if the financial result is negative, the project becomes non-viable (non-feasible); and it becomes viable only if both financial and economic results are positives. However, if there is a possibility of subsidy by a third party, a big private project with negative financial result and positive economic result would be feasible. Table 5 below summarizes the four situations that may be encountered, depending on the possible combinations of economic (ER) and financial (FR) results of evaluation. Financial Benchmark (FB) and Economic Benchmark (EB) are also called opportunity cost. The distinction is made for the case of private and public projects.

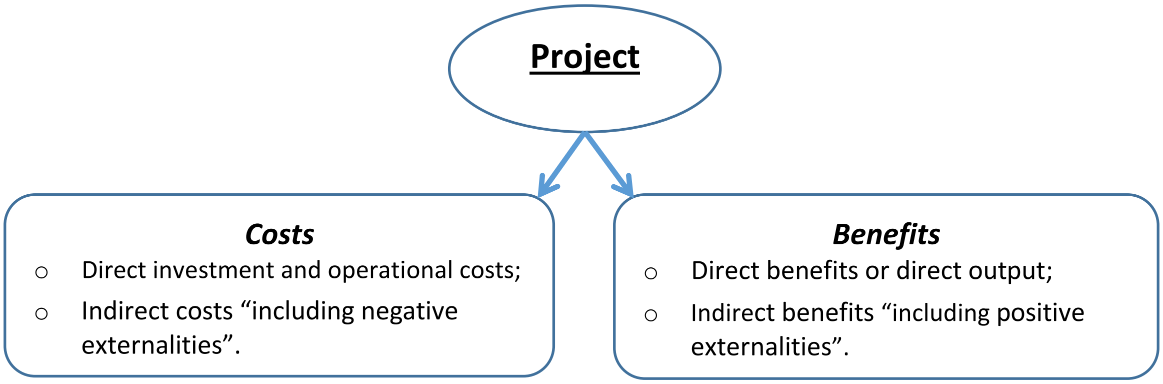
Table 5 Summary of four feasibility situations for private and public projects

	1	**2**	**3**	**4**
Type of Project	**FR > FB ER > EB**	**FR > FB ER < EB**	**FR < FB ER > EB**	**FR < FB ER < EB**
Private Project	Feasible	Feasible (but with taxation)	Non-Feasible (or Feasible with subsidies)	Non-Feasible
Public Project	Feasible	Non-Feasible	Feasible (deficit)	Non-Feasible

Source. Adapted from Garrabé (2013)

3.3.2. Theory of Cost-Benefit Analysis

The cost-benefit analysis is an evaluation approach used to determine the economic feasibility of a project. The total expected economic costs are weighed against the total expected economic benefits (Figure 6). If the benefits or advantages outweigh the costs, over a given period of time, the project is considered to be economically viable. On the contrary case, the project is economically non-viable.



Source. Own elaboration

Figure 6. Total expected costs versus total expected benefits

The cost-benefit analysis method finds its theoretical basis in the economic welfare theory (Oustani *et al.*, 2009). Hence, it is in the logic of neoclassical economics which takes an interest in the question of how a society could allocate its resources optimally to maximize the welfare of the entire community. The welfare of the entire community is maximized when the difference between the total sum of individual benefits and the total sum of individual costs becomes positive. Mathematically, a project maximizes the welfare of the entire community when: $\sum_{i,t}(B_{i,t} - C_{i,t}).(1+s)^{-t} > 0$, where $B_{i,t}$ is the benefit for the individual i at the time t, $C_{i,t}$ the cost for the individual i at the time t and $(1+s)^{-t}$ is the discount rate.

The welfare is generally described by the concept of utility through the consumer theory (Jehle and Reny, 2011). The utility concept reflects the individual preference regarding a set of goods or properties. In other terms, an individual preference for a good or property expresses the degree of welfare that this good or property can procure for this individual. Mathematically, the individual preferences are represented by a binary relation $\precsim$ defined on an individual set of choice *X*. So, whatever x_1, $x_2 \in$ X; if $x_1 \precsim x_2$, this also means that x_1 is at least as good as x_2, for this individual. The utility function (U) is a convenient concept to summarize the information contained in the individual preference relation. So, for x_1, $x_2 \in R^n_+$; $U(x_1) \geq U(x_2) \Leftrightarrow x_1 \precsim x_2$. In other terms, if the good x_1 have a utility superior or equal to the good x_2 for an individual, this also means that the preference for x_1 is superior or equal to x_2 for the same individual and vice-versa.

The neoclassical branch of economics is at the origin of the revolution of the theory of welfare, it appeared at the end of the 19^{th} century and has known its big success in the early 20^{th} century with the economist Pigou (1920), through his book *"The Economics of Welfare"*. This author shows that for each project, there are social and private costs and the difference between those costs reflects the externalities value created by the new project. Thereafter, the economists Kaldor (1939) and Hicks (1939) evoked the principle of compensation. For these two authors, in order to improve the overall welfare of the society, the winners must have the capacity to offer compensation to losers, in such a way that finally there are not losers.

Technical expressions are used in the theory of cost-benefit analysis and need to be well defined. Some are direct and indirect benefits, direct and indirect costs, external stakeholders, passive and active stakeholders and present and future stakeholders.

Benefits, also called advantages, are procured by the new project to a number of persons, group of persons and or a collectivity. Two types of project benefits can be distinguished, direct and indirect. Direct benefits are all benefits procured to stakeholders directly involved in the project (active stakeholders). Indirect benefits are all implicit benefits generated by the project and that could be procured to involved and/or to external stakeholders. These indirect benefits are also called positive externalities when they are generated to external stakeholders.

The same definition and analysis could be done for the project costs. Direct costs are all project investments and operational costs engendered to stakeholders directly involved in the project. Indirect costs are all implicit costs engendered by the new project to involved and/or to external stakeholders. When these indirect costs are engendered to external stakeholders they are also called negative externalities.

External stakeholders, also called passive stakeholders, are all people affected by the new project, even though they are not directly involved in the project. They can be distinguished into present passive stakeholders and future passive stakeholders. Present passive stakeholders are stakeholders who can be immediately affected by the new project, while future passive stakeholders refer to the future generations who could be also affected by the new project.

The economic theory developed in the previous section is at the basis of the quantification principle of benefits and costs of a project using the cost-benefit analysis approach. This quantification of costs and benefits requires specific estimation approaches which are developed in the following section.

3.3.3. Approaches to Quantification of Project Impacts

The cost-benefit analysis is based on the principle of giving financial value to all project impacts considered, which is not always easy. For this reason, the approach draws on several other methods to estimate the financial value of different impacts associated with the new project. All of these estimation methods take the market as a reference, by trying constantly to attribute a market value or indirectly build a shadow price of the different project impacts (Dupuis, 1985). Some of these estimation methods are "substitute goods or services", "complementary private goods or services", "market value of associated product" and "opportunity cost". More particularly, the estimation of natural resource values generally uses other methods such as "hedonic pricing", "travel cost", "factor income", replacement cost", "willing to pay" and "price equivalent measure" (Troy and Bagstad, 2009; Dupuis, 1985).

A substitute product is a product with approximately the same usage as the reference product. A complementary private product is a product who’s use is complementary to the use of the reference product. The associated product is a product derived or linked to the reference product in such a way that knowing the market value of the associated product can help to estimate and build the market value of the reference product. The opportunity cost is generally transversal to the different estimation methods and consists of identifying, for each situation, the alternative optimal use in order to determine the most precise possible value.

The other estimation methods, mainly applied for the estimation of natural resources value and environmental externalities, are generally used when it is not possible to estimate directly the value of the reference good or service.

The hedonic pricing evaluates the benefit of a non-market characteristic, such as pollution or noises, on the market prices. It is mostly used for the analysis of housing prices and reflects the externalities value of the good. The travel cost estimation consists of determining how much travelers pay to visit a resource. The factor income approach aims to analyze the natural resource as a factor of production in another resource. The replacement cost is the cost of engineering a solution to replace the function provided by the natural resource. Willing to pay consists of conducting a survey of the target population by asking them the amount that they are willing to pay in order to continue to use a good or service. Price equivalent measure is the reverse of willing to pay and consists of asking the target population the amount that they are willing to accept in order to abandon the use of a good or service.

Formally, through willing to pay (WP) and price equivalent (PE), the new project maximizes the welfare of the entire community if: $DV(WP) - DV(PE) > 0$; where

DV(WP) represents the discounted value of willing to pay of winners to losers, and DV(PE) the discounted value of willing to accept of losers from winners.

Conducting original valuation studies at the study site using these estimation methods can be extremely costly and take years (Troy and Bagstad, 2009). For this reason, the common approach is to use information generated in other research sites which are contextually similar to the study site. This common approach, known as “value transfer” or “benefit transfer” consists of adapting information and data from existing studies to the new study contexts where valuation data is absent or limited using valuation estimates from the established literature (Desvousges *et al.,* 1998).

Therefore, due to the limited information on the study site and the time constraints, the estimation approach used for the cost-benefit analysis of the extended grazing season project will be mainly based on the value transfer approach. Finally, at the end of economic evaluation, in order to take into consideration the value of money at the time, the discount rate $(1+s)^{-t}$ is applied to convert all monetary outputs to their present value. The S represents the interest rate considered. Some assumptions were taken under this study. These assumptions are presented in the following section.

3.4. Study Assumptions

This study is based on some assumptions that are highlighted below:

- *Yardage, pasture watering systems and wind break costs are estimated from data obtained in literature from Western Canada;*
- *The partial budgeting is only based on reduced and additional expenses (incomes are not taken into consideration). For the financial analysis, incomes are assumed equal for the two feeding systems;*
- *Veterinary and medicine costs are assumed equal for the two feeding plans;*
- *Inputs are assumed constant throughout the study horizon for each feeding plan;*
- *No grain or starchy feeds, including corn silage, are fed to cattle;*
- *Forage costs are based on market prices supplied by Jones (2013 and 2011), which were the most recent data available in the study area;*
- *2.5 acres are considered available per cow/calf per year. This means 1.5 acres on pasture (stocking rate) and 1 acre for forage hay production;*
- *For the project impacts quantification, it is considered there are two kinds of stakeholders represented by an Atlantic beef farmer and the Atlantic region community;*
- *All project impacts listed have not been monetarized.*

3.5. Summary

This chapter deals with the methodology approach used for the study, its theoretical bases and the assumptions under which this study is valid.

The study is based on the cost-benefit analysis approach with two separate components, financial and economic. The financial component will help to determine which feeding system is more financially efficient for an Atlantic beef farmer and will be based on an approach of partial budgeting of farm production costs. The second component, more economic than financial, goes beyond the financial analysis and will allow the determination of which feeding system is the most economically and sustainably efficient for an Atlantic beef farmer and for the whole Atlantic community. The choice of the cost-benefit analysis as the research methodology is based on its capacity for taking into account the multiple questions which appear as challenge for the economic and sustainable development of beef cattle production in the Atlantic region.

Chapter 4. Financial Analysis of Beef Farm Production Costs

This chapter is devoted to the financial analysis of the extending the grazing season project. Financial data used were obtained from estimates of farm production costs in Atlantic Canada (Jones, 2013 and 2011; PEI Cattle Producers, 2013) and from studies carried out in Western Canada (Saskatchewan Forage Council, 2011; Manitoba Agriculture Food and Rural Development, 2015) when data for Atlantic Canada was not available. This financial analysis is based on partial analysis of farm production costs using the method of "partial budgeting" (Boehlje and Eidman, 1984).

In addition to the partial budgeting of farm production costs, the animals' performance is also measured while being fed on extended grazing season practices in Atlantic Canada. Data used for this purpose comes from the Nappan Research Farm (NRF), one of Agriculture and Agri-Food Canada's research facilities specializing in beef production research for the Atlantic region. Because extending the grazing season is not yet a well developed practice in the Atlantic region, the idea here is to verify that this feeding approach does not compromise animals' performance. This performance data will also contribute to verifying the validity of the assumption that the two feeding plans should result in the same incomes. Indeed, the use of extending the grazing season in Western Canada has proven successful in terms of output compared to conventional practices (Kelln *et al.,* 2011; Baron *et al.,* 2014; McCartney *et al.,* 2004).

4.1. Partial Budgeting

Partial budgeting is a farm management approach which aims to estimate the change that will occur in farm profit or loss from some change in the farm management by considering only those items of income and expense that change (Boehlje and Eidman, 1984). Therefore, a partial budgeting approach does not calculate the total income and total expense for each of two plans, but considers only the changes that can create profit or loss for the farmer. Partial budgeting is particularly useful in analyzing relatively small changes in the farming system, such as changes in the feeding plan, the purchase of a piece of equipment to replace hiring a custom operator, participation in a government program, or a change in production planning (Boehlje and Eidman, 1984). The general format of partial budgeting is described in Table 6.

Table 6 General format of partial budgeting

1. Additional Income This section lists the items of income from the alternate plan that will not be received from the base plan.
2. Reduced Expenses This section lists the items of expense for the base plan that will be avoided with the alternate plan.
3. Subtotal (1+2)
4. Reduced Income This section lists the items of income from the base plan that will not be received from the alternate plan.
5. Additional Expenses This section lists the items of expense from the alternate plan that are not required with the base plan.
6. Subtotal (4+5)
7. Difference (3-6) A positive difference indicates that the net income of the alternate plan exceeds the net income of the base plan by the amount shown. A negative difference indicates that the net income of the alternate plan is less than the net income of the base plan by the amount shown.

Source. Boehlje and Eidman (1984)

This study focuses on production costs only, so the analysis will be typically a "partial budgeting of production costs". This means that the analysis will consist of estimating the change that will occur in farm profit by considering only those expense items that change. It is assumed that incomes are equal for the two feeding plans. The two feeding plans refer to a plan based on extending the grazing season and, to a plan based on the common feeding approach followed by Atlantic beef farmers. The idea is to characterize, through a case study, the possible adoption of extending the grazing season in Atlantic beef production by comparing it to the common beef feeding approach in the study area.

The study compares the partial budgeting of production costs from the two feeding plans and determines the most financially efficient plan. The financial efficiency of a system or a plan is its capacity to allow output at a lower cost. As it is assumed that incomes are equal for the two feeding plans, the plan that minimizes the production costs the most will be the most financially efficient.

4.2 Partial Budgeting of Beef Production Costs in Atlantic Canada

In order to determine the value of reduced and/or additional expenses, an Excel spreadsheet was used for an annual partial modeling of beef farm production costs in Atlantic Canada (Table 7). This partial modeling considers the two feeding plans presented above. The conventional feeding represents the base plan and extending the grazing season the alternate plan.

Table 7 Annual partial modeling of beef farm production costs for two feeding plans

Components			Parameter per cow/calf	Conventional feeding plan	Extended grazing season feeding plan
Herd Characteristics	Stocking rate			1.5 acres/pair	1.5 acres/pair
	Carrying capacity			1.5 acres/pair	1.5 acres/pair
	Number of cow/calf pairs			40	40
	Acres for pasture		1.5	60	60
	Acres for production of hay or baled hay forage		1	40	40
Feeding Periods	Summer pasture days			165	165
	Winter pasture days on stockpiled grazing			0	75
	Winter pasture days on bale grazing			0	125
	Total of pasture days			165	365
	Number of days in barn			200	0
	Total feeding days		365	365	365
Production Costs	**Stockpiled Grazing**	Pasture cost	$120.00		$986.30
		Salt and Mineral	$25.00		$205.48
		Yardage cost	$0.36		$1,080.00
	Bale Grazing	Baled hay cost	$282.00		$3,863.01
		Salt and Mineral	$25.00		$342.47
		Yardage cost	$0.40		$2,000.00
	Summer Grazing	As the summer period has the same characteristics for the two feeding plans, it has not been considered in the analysis.			
	Non-Grazing Season	Hay cost	$282.00	$6,180.82	
		Salt and Mineral	$20.00	$438.36	
		Concentrate feed	$0.00	$0.00	
		Yardage cost	$0.90	$7,200.00	
		Straw bedding cost	$55.16	$2,206.40	
Subtotal (1) = Reduced Expenses = (a) - (b) = <u>$7,548.32</u>				**$16,025.58 (a)**	**$8,477.26 (b)**
Other Costs	Wind Break cost		$1.5	$0.00	$60
	Training on management skills cost			$0.00	$40.00
	Pasture watering system		$2.91	$0.00	$116.40
Subtotal (2): Additional Expenses = (d) - (c) = <u>$216.40</u>				**$0.00 (c)**	**$216.40 (d)**

The modeling approach is based on a farm with 40 cow/calf pairs and 100 acres of farmland, of which 60 acres is for pasture and 40 acres is for forage hay production. These values correspond to the mean in the study area. The "parameters per cow/calf" are expressed per year except yardage cost which is expressed per day. The modeling strategy considers four components for each feeding plan: herd characteristics; feeding periods; production costs; and other costs. The effective cost of items for each feeding period is estimated from published data for the region, and published data for western Canada where data for Atlantic Canada is unavailable.

The herd characteristics component includes stocking rate, carrying capacity, number of cow/calf pairs, available acres for pasture and available acres for hay production. Stocking rate is defined as the number of animal units per unit area over a given period of time, while the carrying capacity is the maximum long-term stocking rate possible without detrimental effects on the land resource (Mark and Matthew, 2007). For this study the stocking rate is represented as the number of acres utilized by one cow/calf pair to facilitate calculations, as most cost of production parameters are expressed in $/acre. The stocking rate corresponds to 1.5 acres of pasture per cow/calf pair and 1 acre of produced hay per cow/calf pair when they are not grazing. The carrying capacity is assumed to be the same as the stocking rate in the calculations.

The feeding periods are subdivided according to each feeding plan. For the extended grazing season feeding plan, the feeding year is subdivided into three periods: 165 days of extensive stockpiled grazing from mid-May to the end of October; 75 days of winter feeding on intensive stockpiled grazing from November to mid-January; and 125 days of winter feeding on bale grazing from mid-January to mid-May. This subdivision of feeding periods takes into consideration Atlantic weather conditions and the possibility to capitalize on extended grazing season approaches for winter feeding. For the conventional feeding plan, the feeding year is subdivided into two periods: 165 days of extensive stockpiled grazing from mid-May to the end of October; and 200 days of barn feeding with baled hay from November to mid-May.

As the summer period has the same characteristics for the two feeding plans, it has not been considered in the analysis as it does not bring any change in the comparison of costs for the two plans.

The production costs component refers to feed cost, yardage cost and straw bedding cost associated with the different feeding periods for each feeding plan. In general, farm production costs can be classified as direct and indirect costs (Saskatchewan Forage Council, 2011). Direct costs include feed, bedding, minerals and supplements and veterinary expenses. Indirect costs refer to yardage costs, including manure removal cost. According to Saskatchewan Forage Council (2011), yardage cost is "*an expression of indirect costs including ownership (depreciation, housing, insurance and interest costs) and operating costs of facilities, repair and maintenance of machinery and equipment, fuel, labour, management, utilities, property tax and general and administrative costs. These costs are often charged as head days fed or grazed*". For this study, veterinary costs are not considered as it is assumed equal for the two feeding plans. Indeed, if extending the grazing season reduces veterinary intervention it also increases the use of deworming as grazing animals can increase infestation by gastrointestinal parasites (Butler *et al.*, 1993). The feed costs, supplied by Jones (2011 and 2013), are costs for pasture forage, baled hay forage, salt and minerals. The cost of improved pasture forage was estimated at $80 per acre per year (Jones, 2013). Therefore, by considering 1.5 acres per cow/calf on pasture and a farm size of 40 cow/calf pairs, the total pasture cost is

$986.30 for the stockpiled grazing period. The cost of baled hay per cow/calf pair per year was estimated at $282 (Jones, 2011), for a total baled hay cost of $3,863.01 for the bale grazing period and $6,180.82 for the non-grazing period. From Jones (2013), the cost for salt and mineral was estimated at $25 per cow/calf pair per year, giving a total of $205.48 for the stockpiled grazing period, $342.47 for the bale grazing period and $438.36 for the non-grazing period. Yardage costs for different feeding periods (Appendix A) is estimated from a study carried out in western Canada (Saskatchewan Forage Council, 2011). The estimated values per cow/calf per day are $0.36 for stockpiled grazing, $0.40 for bale grazing and $0.90 for the non-grazing season. This leads to a respective total yardage cost of $1,080.00 for the stockpiled grazing period, $2,000.00 for the bale grazing period and $7200 for the non-grazing period. The straw bedding cost is the amount spent during winter to purchase bedding used to feed animals in the barn. This cost, estimated at $55.16 per cow/calf pair per year, was obtained from a report on Prince Edward Island (PEI) cost of production (PEI Cattle Producers, 2013). For 40 cow/calf pairs, straw bedding cost corresponds to a total of $2,206.40 per year. Straw bedding is no longer required under the extended grazing season feeding plan given the fact that animals are raised completely on pasture, so this is a cost savings in the alternate feeding plan.

The last component refers to additional costs associated with the alternate plan. These additional costs include costs for a windbreak, pasture watering system and training on pasture management skills. Apart from the cost for training on management skills, the two other costs in this component were estimated from a study carried out in western Canada (Manitoba Agriculture Food and Rural Development, 2015). For the windbreak, the data shows that it could cost up to $2.91 per cow/calf per year. However, given the physical characteristics of the Atlantic region with a lot of trees that can potentially play the role of windbreak, farmers should not have to spend much money on an artificial windbreak. For this reason, the value of windbreak in Atlantic Canada was estimated at half of the value from western Canada at around $1.50 per cow/calf per year, which means a total amount of $60 for 40 cow/calf pairs per year. The watering system cost was estimated from western Canada data at $2.91 per cow per year, for a total amount of $116.40 for 40 cow/calf pairs per year. The cost for training on management skills was estimated at $40 as a reasonable cost per farmer per year to develop skills on grazing management and strategies to extend the grazing season. We assume this training is done by the beef farmers' association with a registration fee of each member.

This partial modeling of beef farm production costs shows two important outputs: subtotal (1) and subtotal (2). Subtotal (1) refers to expenses for the conventional feeding plan that will be avoided by extending the grazing season. Subtotal (2) refers to additional expenses from the extended grazing season feeding plan that are not required with the conventional feeding plan. Results are summarized in Table 8.

Table 8 Partial budgeting of beef farm production costs in Atlantic Canada

1. Reduced Expenses = Subtotal (1) = $7,548.32
2. Additional Expenses = Subtotal (2) = $216.40
3. Difference (1-2) = $7,331.92
This difference reflects that the net financial benefit of the alternate plan exceeds the net financial benefit of the base plan.

The results show that extending the grazing season can contribute to avoiding an expense of $7,331.92 per farm per year. These expenses are avoided through eliminating and/or reducing the overwintering costs for feed (16%), yardage (55%) and straw bedding (29%) (Figure 7).

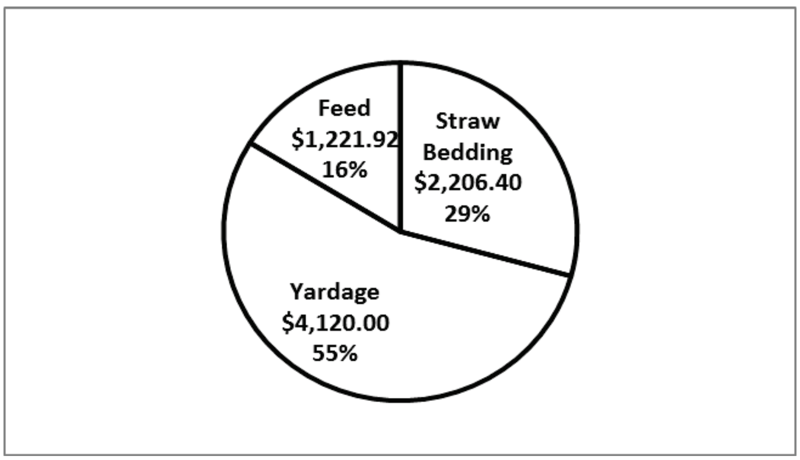


Figure 7. Expenses avoided per beef farm per year by extending the grazing season

With the extended grazing season feeding plan, animals are raised completely on pasture, which means that a farmer will no longer need to spend $2,206.40 per year for straw bedding. Grazing animals on pasture also indicates that there is an opportunity for Atlantic beef farmers to save additional costs including feed, building depreciation and repairs, machinery, fuel, labour, manure removal, etc. The model shows that feed and yardage costs can be reduced by $1,221.92 and $4,120 respectively for an Atlantic beef farm each year. This means a total annual avoided cost of $7548.32, with a net cost saved of $7,331.92 per year when taking into account the additional cost of $216.40 per farm per year (Table 8).

The period considered for the study is the overwintering period which goes from November to mid-May (200 days), as the summer period is not taken into account. By considering these 200 days, the model indicates that extending the grazing season can lead to a saving of $0.92 per cow/calf per day. This means that, as the number of cattle days on pasture increases, there will be a greater reduction in production costs (Figure 8).

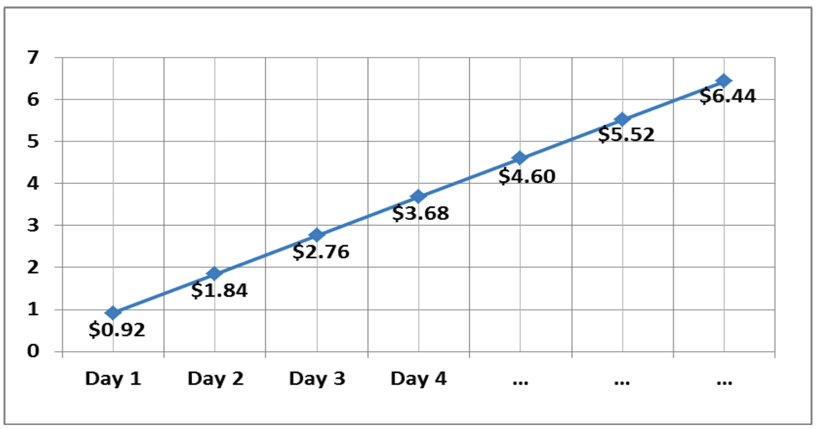


Figure 8. Expenses avoided per cow/calf days on winter grazing feeding

Extending the grazing season is thus financially the most efficient feeding plan for Atlantic beef producers. This result corroborates many results from western Canada showing the contribution of extending the grazing season to reducing winter production costs in beef production (Kaliel, 2004; Baron *et al.,* 2014; McCartney *et al.,* 2004). Atlantic beef producers may thus improve the financial viability of their farm through the adoption of the extended grazing season feeding plan in their production system.

4.3. Animal Performance Under Extending the Grazing Season in Atlantic Canada

The performance of beef cattle under extended grazing season conditions were analyzed through calculation of their body weight (BW) and body condition scores (BCS) while on bale grazing at NRF. The available data obtained from NRF were animals' BW and BCS at the time they began the bale grazing period and again when the bale grazing period ended (Appendix B). These data were used to calculate the average daily weight gain and the average rate of change in body condition scores. Animals bale grazed in three successive winter periods: the first period with 68 beef cattle from December 11, 2013 to February 24, 2014; the second period with 61 beef cattle from December 16, 2014 to March 09, 2015; and the third period with 59 beef cattle from December 29, 2015 to March 08, 2016. For all three grazing periods, animals are introduced on bale grazing while they are in the middle of pregnancy. The scale used for BCS at NRF is 1-9 points and the calving period is during the spring, usually in April or early May. The results are summarized in the following Table 9.

Table 9 Animal Body Weight (BW) gain and BCS change under winter bale grazing

	Periods	Animal head	Average weight	Average BCS
1st Period (65 days)	Put into Bale Grazing	68	1574.485	7.198
	Taken out of Bale Grazing	68	1582.5	5.882
	BW gain (lbs) and BCS change		**+ 0.123**	**-1.316**
2nd Period (85 days)	Put into Bale Grazing	61	1600.246	6.426
	Taken out of Bale Grazing	61	1645.902	6.303
	BW gain (lbs) and BCS change		**+ 0.537**	**- 0.123**
3rd Period (70 days)	Put into Bale Grazing	59	1536.271	6.576
	Taken out of Bale Grazing	59	1570.763	6.788
	BW gain (lbs) and BCS change		**+0.493**	**+0.212**

Given an animal's physiological status, it would be difficult to obtain a reliable body weight gain due to the interaction of the weight of maternal tissues with specific physiological stages such as pregnancy (Gionbelli *et al.,* 2015). In this situation, the body condition score, closely related to beef reproductive efficiency, is a more reliable indicator of the nutritional status of beef cattle (Rasby *et al.,* 2007).

The body condition score presents double advantages to help estimate the beef probability of re-breeding as well as the calving conditions. A high BCS may result in calving issues mainly by increased dystocia; while a low BCS may compromise beef re-breeding capacity mainly by increasing the post-partum interval. These situations could result in reduced income for beef farmer. According to Parsons (2009), it is recommended that mature cows calve with a BCS of at least 5 and not more than 7. Also, at NRF, it is generally expected that cattle will calve with a BCS between 5.5 and 6.5. The BCS at calving time on bale grazing, which fall between 5.882 and 6.788 (Table 9) are thus appropriate to allow good reproductive performance of beef cattle. These results, and the observations of beef specialists who conducted the study at NRF, reflect that animals have been able to maintain good performance on winter bale grazing in Atlantic Canada.

Given these results of three trials at Nappan Research Farm it is possible to say that, in the Atlantic region, beef cattle are able to maintain good performance in an extended grazing season feeding system. This result corroborates other results from western Canada showing that animals' performance on extended grazing season methods were comparable to conventional feeding practices (Kelln *et al.,* 2011; Baron *et al.,* 2014). An extended grazing season feeding plan can thus procure an output comparable to the conventional feeding plan in Atlantic beef production.

4.4. Summary

This chapter was devoted to the financial analysis of the extended grazing season project in Atlantic beef production through the partial budgeting of beef farm production costs. It shows that extending the grazing season is financially efficient for an Atlantic beef farmer, as it can contribute to avoiding an expense of $7,331.92 per farm per year. A detailed analysis shows a saving of $0.92 of the overwintering production costs per cow/calf per day. Furthermore, the results of animals' performance show that beef cattle are able to maintain good performance on an extended grazing season feeding plan. This feeding approach would be thus an alternative solution to reduce production costs and enhance beef farm viability in Atlantic Canada.

However, in order to take into consideration the impact of the extended grazing season project at the scale of the Atlantic region, it would be relevant to go beyond the financial analysis by determining the economic value for an Atlantic beef farmer and for the Atlantic community. This leads to the next chapter devoted to the economic analysis of the extended grazing season project for Atlantic beef production.

Chapter 5. Economic Analysis: Project Impacts Quantification

This chapter addresses the economic component of the cost-benefit analysis of the project of extending the grazing season in Atlantic beef production. The purpose is to determine the economic efficiency of the project. The economic efficiency reflects the capacity of a system to allow more benefits than costs to a group of stakeholders and/or to the whole community situated in the social space of the study. To carry out this economic analysis, the cost-benefit analysis protocol is applied to the project of extending the grazing season in Atlantic beef production.

5.1. Protocol of Cost-Benefit Analysis

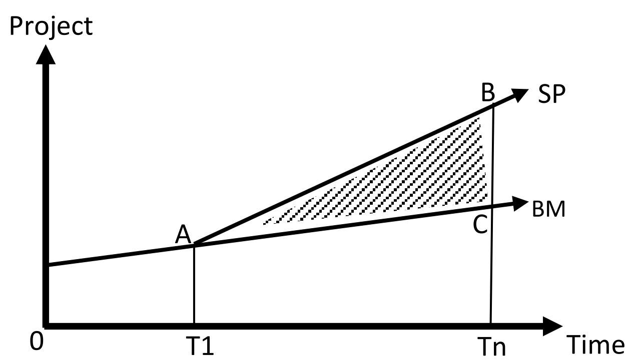
The steps of cost-benefit analysis used for this study are based on the steps enumerated by Oustani *et al.* (2009) in addition to other resources, such as Garrabé (2013) tools for cost-benefit analysis. These steps are described as follows.

5.1.1. Identification of Project Objectives, Economic and Social Space

The main challenge of the project is to integrate economic, forage agronomy and livestock production data to determine the economic costs and benefits of management techniques that can extend the grazing season for Atlantic beef production. The purpose of the study is to determine the economic value of the extended grazing season project for two types of stakeholders represented by an Atlantic beef farmer and the whole Atlantic community.

5.1.2. Identification of the Benchmark

The benchmark refers to the situation without the project and its normal evolution (Figure 9). Indeed, the new project can be considered as an external shock which comes at the time T1 and changes the evolution of the benchmark. However, without the new project, the benchmark will not remain stable; it will pursue its normal evolution in a situation without the project.



Source. Adapted from Garrabé (2013)
Figure 9. Graphic representation of the benchmark of the project

The net benefit (NB) generated by the new project is the difference between the discounted benefit (DB_{SP}) of the situation with the project (SP) and the discounted benefit (DB_{BM}) of the situation without the project also called the benchmark (BM). Formally this net benefit is presented as following: $NB = \sum DB_{SP} - \sum DB_{BM}$; and it is represented in the Figure 9 by the triangle ABC.

The reference situation reflects the common feeding approach (conventional feeding approach) followed by farmers in the study area and its evolution without the extending the grazing season project. The common feeding approach in Atlantic

Canada is essentially based on pasture and hay. Only a very few beef producers use concentrate feed. The most common pasture used is the naturalized pasture and producers usually practice extensive grazing with unimproved pasture. The most frequent type of production is the cow/calf production system. The subdivision of the feeding system is generally in two time periods: on pasture from mid-May to the end of October or early November and in the barn the rest of the year. In term of days, it is common to say that, in Atlantic Canada, the year corresponds to around 200 cattle days in the barn and 165 cattle days on summer pasture. The average farm size is 40 cow/calf pairs with around 100 acres of farmland available and a stocking rate of 1.5 acres / pair.

5.1.3. Identification of Project Impacts

This step consists of identifying the possible direct and indirect impacts of the extending the grazing season project in Atlantic beef production (Table 10).

Table 10 Direct and indirect impacts of the extended grazing season project

Direct Impacts	Indirect Impacts
o Reduce feed and feeding costs; o Reduce or eliminate bedding and manure management costs; o Increase animal parasitic diseases; o Reduce Vet costs; o Increase uncertainties on farm management with weather conditions; o Induce need of best management skills for farmers; o Ensure soil retention and erosion control; o Improve animal welfare; o Induce need of wind Break; o Induce need of watering system.	o Limit negative perceptions of livestock; o Reduce risk associated with chemical fertilizers; o Reduce water pollution associated with phosphorus and nitrate; o Ensure landscape maintenance; o Ensure recreation function; o Contribute to GHG mitigation; o Reduce labour demand in agriculture; o Reduce demand of agricultural machinery and equipment; o Increase farmland market value; o Improve animal products market value; o Develop forage market; o Improve soil fertility.

Source. Own elaboration inspired from Anderson and Settle (1990) cited by Oustani *et al.* (2009)

The project impacts can be related to internal and/or external stakeholders. The idea is to make an inventory of all possible impacts that could be associated to the extending the grazing season project. Direct impacts are all impacts directly associated to the existence of the new project; while indirect impacts are all implicit impacts generated by the new project. Indirect impacts appear as the consequence of the existence of the extending the grazing season project in Atlantic Canada.

5.1.4. Selection and Classification of Project Impacts

In this step, direct and indirect impacts are classified as tangible and intangible (Figure 10). Tangible impacts are all evident and easily quantifiable impacts; while intangible impacts are impacts that are non-evident and non-easily quantifiable.

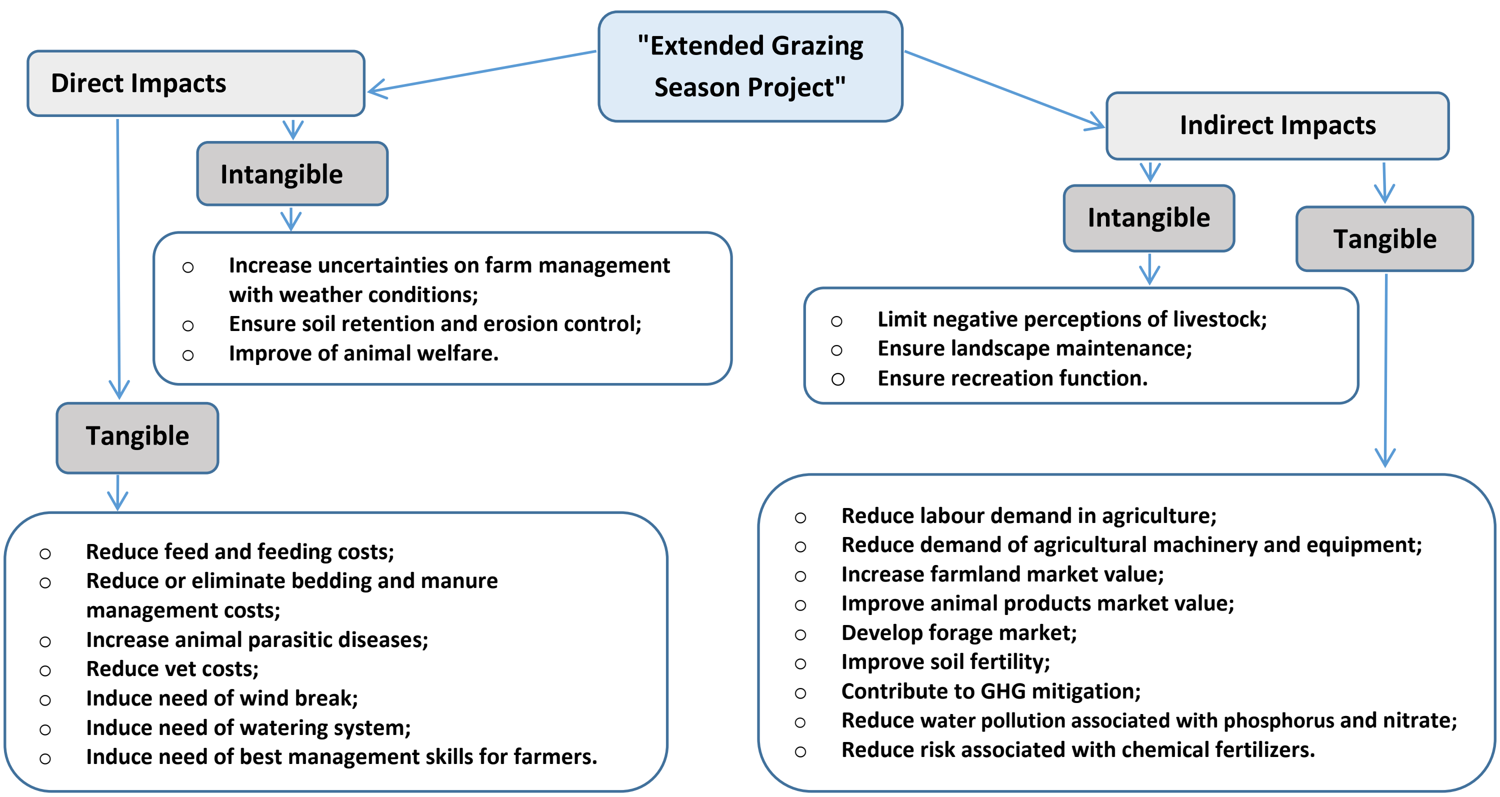


Figure 10. Classification of impacts of the extended grazing season project
Source. Own elaboration inspired from Anderson and Settle (1990) cited by Oustani *et al.* (2009)

5.1.5. Quantification of Project Impacts

This step is devoted to the estimation of direct and indirect benefits and costs of the extending the grazing season project in Atlantic beef production. All estimated amounts are converted to their present value (2016 year) through the Bank of Canada online system[2]. These estimations of benefits and costs, in Canadian dollars ($CAD), are presented in the following sections.

5.1.5.1. Estimation of Direct Tangible Benefits and Costs

The direct tangible benefits and costs refer to the results of the financial analysis of the project. Therefore, the final result as shown in Table 11 corresponds to the expenses saved per beef farmer per year through extending the grazing season. This was calculated above partial budgeting of production costs section and corresponds to **+$7,331.92.**

This final result is positive and reflects the direct tangible economic benefit per farm and per year that could be provided by extending the grazing season.

Table 11 Direct tangible benefits and costs per farm and per year

Direct tangible benefits	**Direct tangible costs**
Reduce feed and feeding costs	Induce need of wind Break
Reduce or eliminate bedding and manure management costs	Induce need of watering system
Reduce Vet costs	Induce need of best management skills for farmers
	Increase animal parasitic diseases
Result (1) = + $7,331.92	

[2] http://www.bankofcanada.ca/rates/related/inflation-calculator/

5.1.5.2. Estimation of Direct Intangible Benefits and Costs

The quantification of direct intangible impacts is devoted to three elements which are: “increase uncertainties on farm management with weather conditions”, “ensure soil retention and erosion control” and “improve animal welfare”.

The benefit generated through the soil retention and erosion control was estimated using the study carried out by Troy and Bagstad (2009) (Appendix D). These two authors estimated at $4 per hectare / per year the benefit procured by grassland systems in terms of soil retention and erosion control. For the study, 100 acres of farmland are considered per Atlantic beef farmer, which is equivalent to around 40 hectares. The total benefit procured per farm and per year would be thus 4*40 = $160 (2009), which in 2016 value corresponds to **$179.54**.

The cost associated with the increasing of uncertainties of on farm management with weather conditions was estimated through a possible insurance for the risk related to uncertainties with weather conditions. The Risk Management Program (RMP) for livestock was used to estimate the cost of this insurance. The RMP is a type of insurance program developed by the Ontario government to help Ontario producers offset losses caused by fluctuating commodity prices and production costs. Although this Ontario program is mainly dedicated to help producers face livestock price volatility, it is assumed there is a possibility to build the same program to help Atlantic beef farmers face weather condition risks associated to the extended grazing season plan. Therefore, the yearly insurance premium of $14.36

per cow/calf used for Risk Management Program in Ontario is used to estimate the cost of an insurance premium to cover Atlantic beef farm against uncertainties with weather conditions[3]. By considering the average farm size of 40 cow/calf pairs, the estimation leads to a cost of **$574.4** per farm per year. It is important to note that the link between the risk management program and the uncertainties with weather conditions is not so strong. This risk management program was used for the estimation by reason that it was the only option found during the study.

Extending grazing season can contribute to improving animal welfare compared to feeding animals in a confined area (Gerlach, 2014). Grazing can also improve the physical fitness of cows (Fredeen *et al.*, 2002). However, this advantage offered by the extended grazing season feeding plan has not been monetarized.

Table 12 summarizes the direct intangible benefits and costs of the extending the grazing season project. The direct intangible result of the project is negative: **-$394.86.** This result reflects the direct intangible economic cost per farm and per year that could be associated with the extending the grazing season project.

Table 12 Direct intangible benefits and costs per farm and per year

Direct intangible benefits	Amount	Direct intangible costs	Amount
Ensure soil retention and erosion control	$179.54	Increase uncertainties on farm management with weather conditions	$574.4
Improve animal welfare	-		
Total Benefits	$179.54	**Total Costs**	$574.4
Result (2) : Total Benefits – Total Costs = - $394.86			

[3] http://www.agricorp.com/en-ca/Programs/RMP/Cattle/Pages/Rates.aspx

5.1.5.3. Estimation of Indirect Tangible Benefits and Costs

The quantification of indirect tangible impacts is devoted to the nine following elements: “Reduce labour demand in agriculture”, “reduce demand of agricultural machinery and equipment”, “increase farmland market value”, “improve animal products market value”, “develop forage market”, “improve soil fertility, “contribute to GHG mitigation”, “reduce water pollution associated with phosphorus and nitrate” and “reduce risk associated with chemical fertilizers”.

For the reduction of the labour demand in agriculture, it could be considered as a cost or as a benefit for the Atlantic community. However, given today’s context of limited labour availability in agriculture, this reduction appears more a benefit than a cost. In order to avoid double counting, it is assumed that this benefit was already taken into account in the section of direct tangible impacts quantification.

Regarding the possible reduction of the demand of agricultural machinery and equipment, it is assumed that this reduction could contribute to reducing the agriculture contribution for environmental pollution and to reducing the production costs. However, this environmental benefit has not been monetarized. It is also assumed that the contribution to the reduction of production costs was already taken into account in the section of direct tangible impacts quantification.

For the improvement of animal products market value, the literature review of economics of consumer perceptions and preferences carried out by Yiridoe *et al.* (2005) shows that, overall, most consumers in North America (USA and Canada) are willing to pay at least 10% of price premiums for organic products. The grassland systems offer the opportunities to produce high-quality foods with higher market value than similar products derived from intensive livestock industries (Boval and Dixon, 2012). Although grassland products are not automatically organic products, they can offer the possibility to improve beef meat market value. This could be possible, for example, through a label of pasture raised beef. In order to estimate this improvement of beef market value, 10% was added to farmer net benefit on the conventional beef feeding approach. Through Statistics Canada (table 002-0035), the average net operating income per beef farm in Canada in 2013 is 9 461$, including the average net program payments of $4 938 and the average net market income of $4 523. It was not possible to determine the specific average net market income for Atlantic Canada and for this reason the national value has been used. By adding 10% to the national average net market income per beef farm, this would lead to: 4563*10% = $456.3 of benefit per farm per year, which corresponds to **$476.99** in 2016 value.

Extending the grazing season can contribute to the development of the forage market and thus offer the opportunity to beef farmers to produce and sell hay forage. In fact, the reduction of labour demand associated to the extending the grazing season may offer beef farmers free time that they can allocate to other purposes. It is assumed farmers allow some of this free time to produce two acres of baled hay per year. Considering Jones (2011), the estimated benefit procured by one acre of baled hay is $69. So, the yearly benefit generated by two acres of bale hay would be: 69*2= $138 per farm per year, which corresponds to **$148.54** in 2016.

For the reduction of risks associated with chemical fertilizers, Debailleul *et al.* (2003) present results of the study carried out by Brethour and Weersink (2001) (Appendix C). The authors show that the benefit generated by the decreased use of pesticides during the period from 1983 to 1993 in Ontario area was $188USD per household per year. It is assumed that extending the grazing season can procure the same advantages per Atlantic beef farm. The Canada online bank system only shows foreign currency converter for the past 10 years. For this reason, it is assumed that $188USD in 2001 has approximately the same value in 2006. This assumption makes sense, as $CAD is into the floating exchange regime rate with high fluctuations over the years. Through the Canada online bank system it is estimated that in today's currency ($CAD in 2016) of $188USD (in 2006)[4]; and this amount corresponds to **$252.05**.

For the reduction of water pollution associated with phosphorus and nitrate, Debailleul *et al.* (2003) present the results of the studies carried out by Mathews *et al. (*2002) and Van Kooten *et al.(*1998) (Appendix C) related to water pollution by phosphorus and nitrate respectively. Mathews *et al. (*2002) have estimated the benefit generated by the reduction of 40% of water pollution associated with

[4] http://www.bankofcanada.ca/rates/exchange/10-year-converter/

phosphorus in Minnesota State (USA) at $140USD per household per year. Van Kooten *et al. (*1998) show that in British Columbia (Canada), the amount that the population is willing to pay for the reduction of nitrate in the water was on average $172.50 per household per year. As extending the grazing season can contribute to reducing water pollution by phosphorus and nitrate, through best management of manure, it is assumed the same advantages per Atlantic beef farm per year. For the phosphorus reduction, this means a benefit of $140USD per farm per year, which corresponds to $187,70CAD value in 2016. For the nitrate reduction, the benefit would be $172.50CAD (1998 currency) per beef farm per year, which corresponds to $240.63CAD in 2016. In total, the contribution of extending of the grazing season in term of reduction of water pollution by phosphorus and nitrate corresponds to: $187.70 + $240.63 = **$428.33** per farm per year. This reduction of water pollution is also very important in the Atlantic region for a better development of fisheries and seafood production. The preservation of water quality can limit some problems such as eutrophication which could constrain the survival of aquatic species.

Extending the grazing season can increase soil fertility and reduce production costs through good distribution of manure and elimination manure spreading costs, as animals spread the manure themselves. It could also reduce or eliminate the costs associated with purchasing fertilizers. The elimination of costs associated to manure spreading was already taken into account in the section of direct tangible impacts quantification. For the cost associated with purchasing fertilizers, Jones (2011) estimated the fertilizer cost to produce forage hay at $111.8 per acre per year. For 100 acres of farmland available per beef farm, 40 acres are devoted for forage hay production. By supposing a reduction of half of the fertilizer cost per year through the increasing of soil fertility, the benefit generated would be: (111.8/2)*40 = $2236CAD per farm per year, which corresponds to **$2406.83** in 2016.

For the contribution to GHG mitigation, Kulshreshtha *et al.* (1999) estimated the environmental impact of livestock waste in Atlantic Canada at 719.45 kilo tonnes CO2-equivalent a year. Given the fact that manure management is one of important benefits of grazing animals on fields, extending the grazing season can substantially contribute to reducing the environmental impact of livestock waste. Furthermore, grasslands are potentially a carbon sink, which means that extending the grazing season can contribute to greenhouse gas mitigation. At the same time, some studies have shown that most of GHG emissions in cattle production come from pasture based systems due to low enteric emissions from feedlot systems (Vergé *et al.*, 2008; Beauchemin *et al.*, 2010). However, it is known that, even if the pasture based system emits the most GHG, this could be completely balanced in favour of its other multiple services including habitat for wildlife, recreation functions, carbon sink and environment protection (Beauchemin *et al.*, 2010). Given the state of knowledge on the topic, it was not be possible to quantify and counterbalance the negative and positive contributions of the project to greenhouse gas emissions. For this reason, this element has not been monetarized.

Regarding the increase of farmland market value, it is important to note that the estimation of farmland value is very complex as it depends on many different factors. These factors include the expected return from agricultural production, the soil fertility, the agriculture characteristics in the area, the land supply in the county, the population density, the presence of natural amenities, the urban proximity and the non-agricultural farmland demand (Drescher *et al.*, 2001). Also, the farmland price generally increases every year. Due to these variable factors, which directly affect the farmland rental price, it was very difficult to determine the rental cost based on literature. Therefore, it is considered the current rental price of farmland in Atlantic Provinces based on information captured from beef cattle specialists in the region. This leads to a price of $20 per acre per year. By considering an increase of 5% of farmland price due to the development of extended grazing season practices, the value added will be: 20*0.05 = $1 per acre. Therefore, for a farmer who rents all of the land for his production (100 acres), the extra cost of farmland for him would be 1*100 = **$100** per year. However, it is important to note that this situation constitutes a cost only for farmers who rent land. In other terms, the farmers who have sufficient land for their production and do not have to rent land are not affected by this increase of farmland value which could be an advantage for them if they have extra farmlands to rent. However, for this study, this situation is considered as a cost rather than a benefit for an Atlantic beef producer.

Table 13 summarizes the indirect tangible benefits and costs of the extending the grazing season project. In sum, the indirect tangible result is positive: **+ $3612.74.** This result reflects the indirect tangible economic benefit per farm and per year that could be provided by extending the grazing season.

Table 13 Indirect tangible benefits and costs per farm and per year

Indirect tangible benefices	Amount	Indirect tangible costs	Amount
Reduce labour demand in agriculture	-	Increase farmland market value	100$
Reduce demand of agricultural machinery and equipment	-		
Improve animal products market value	$476.99		
Develop forage market	$148.54		
Reduce risk associated with chemical fertilizers	$252,05		
Reduce water pollution associated with phosphorus and nitrate	$428.33		
Improve soil fertility	$2406.83		
Contribute to GHG mitigation	-		
Total Benefits	$3712.74	**Total Costs**	$100
Result (3) : Total Benefices – Total Costs = + $3612.74			

5.1.5.4. Estimation of Indirect Intangible Benefits and Costs

The quantification of indirect intangible impacts is devoted to the three following elements: "Limit negative perceptions of livestock", "ensure landscape maintenance", and "ensure recreation functions".

For the negative perceptions of livestock, it is considered that extending the grazing season could limit some ethical constraints in the origin of negative perceptions of livestock by society. These negative perceptions include, among other, competing with humans for food (Buddle *et al.*, 2011; Beauchemin *et al.*, 2010), the problem of animal welfare (Gerlach, 2014) and the quality of animal products (Boval and Dixon, 2012). However, this possible reduction of negative perceptions of livestock by society has not been monetarized.

For the landscape maintenance, Debailleul *et al.* (2003) present the study carried out by Drake (1999 and 1992) (Appendix C), where the author shows that, in general, in Sweden, populations are willing to pay 970SEK per cultivated hectare per year for natural landscape preservation. According to Debailleul *et al.*, 1SEK in 1990 was equivalent to $0.17CAD in 1990. Therefore, 970SEK in 1990 is equivalent to $164.9CAD in 1990, which corresponds to $272.61 today. Considering 100 acres per farms (40 hectares), the farm contribution to landscape maintenance is estimated at: 272.61*40 = **$10 904.4** per farm per year. This value is may be overestimated given the Canadian context; however it could also reflect new government policies which try to bring awareness and give more importance to environmental protection.

For the recreation functions, the study of Troy and Bagstad (2009) (Appendix D) estimated the recreation functions of grassland systems at 53$ per hectare per year. By considering 40 hectares per farm, this leads to 53*40 = $2120 as a contribution in term of recreation functions per farm per year, which corresponds to **$2378.90** in 2016 value.

The Table 14 summarizes the indirect intangible benefits and costs of extending the grazing season. In sum, the indirect intangible result is positive: **+ $13 283.3.** This result reflects the indirect intangible economic benefit per farm and per year that could be provided by extending the grazing season.

Table 14 Indirect intangible benefits and costs per farm and per year

Indirect intangible benefits	Amount	Indirect intangible costs	Amount
Limit negative perceptions of livestock	-		
Ensure landscape maintenance	$10 904.4		
Ensure recreation functions	$2378.90		
Total Benefits	**$13 283.3**	**Total Costs**	$0
Final Result (4) : Total Benefits – Total Costs = + $13 283.3			

5.1.6. Annual Economic Result per Each Stakeholder

5.1.6.1. Annual Economic Result for Beef Farmer

To determine the annual economic result for an Atlantic beef farmer, only the costs and benefits quantified above which directly affect the farmer are considered. Table 15 describes the annual economic result for an Atlantic beef farmer. The calculation shows an annual economic result in the amount of **+$9689.54** per Atlantic beef farmer under extending the grazing season.

Table 15 Annual Economic result for an Atlantic beef farmer

Impacts	Benefits	Costs
Result (1) of direct intangible impacts	**+$7,331.92**	-
Increasing uncertainties on farm management with weather conditions	-	-$574.74
Improvement of the market value of animal products	+$476.99	-
Development of forage market	+$148.54	-
The improvement of soil fertility	+$2406.83	-
Increasing of farmland market value		-$100
Final Result: +$7,331.92 - $574.74 + $476.99 + $148.54 + $2406.83 - $100 = **+$9689.54**		

5.1.6.2. Annual Economic Result for the Community of Atlantic Canada

To determine the annual economic result for the whole Atlantic community, the sum of all final results from Table 11 to Table 14 is multiplied by the number of Atlantic beef farms. According to the recent general agriculture census[5], the number of beef farms in Atlantic Canada was 1080 in 2011. It is assumed that the adoption of this new feeding plan would be by the whole community of Atlantic beef farmers. Hence, the annual economic result for the Atlantic community can be described in Table 16. The calculation shows an annual economic result in the amount of **+ $25 739 748** for the Atlantic region under extending the grazing season.

Table 16 Annual Economic Benefit for the Atlantic Region

Results	
Result (1) of Table 11	**+$7,331.92**
Result (2) of Table 12	-394.86
Result (3) of Table 13	+13283.3
Result (4) of Table 14	+3612.74
Number of Atlantic beef farms considered	1080 in 2011
Final Result: = [+7,331.92- 394.86 + 13283.3 + 3612.74]*1080 **= +$25 739 748**	

5.1.7. Choice of Economic Discount Rate and Definition of the Study Horizon

The study carried out by Jenkins and Kuo (2007) suggests that, *"for Canada an 8 percent real rate is an appropriate discount rate to use when calculating the economic net present value of the flows of economic benefits and costs over time"*. This real rate of discount of 8% is also supported by the Government of Canada

[5] Table 004-0014, Agriculture General Census

(2007). Therefore, for the study it is considered 8% as economic discount rate. And for the study horizon, a reasonable horizon of production of 15 years is considered.

5.1.8. Economic Result on the Study Horizon: Calculation of NPV

In this section, the economic net present value (NPV) for the beef farmer and for the Atlantic community is calculated in a horizon of 15 years. Through the economic discount rate of 8%, the discount factor is calculated. This discount factor can be determined using a table of discount rate or mathematically as follows: $[1/(1+8)]^t$; where t corresponds to the year. As NPV is positive for each year in the study horizon, for both the beef farmer and the Atlantic community, there is no requirement to calculate the economic IRR (Internal Rate of Return).

The economic results of the extending the grazing season project in Atlantic beef production are presented in Table 17. These results are presented for 2 types of stakeholders: An Atlantic beef farmer and the whole Atlantic community.

Table 17 Economic results of the extended grazing season project in Atlantic Canada

years	**1**	**2**	**…**	**14**	**15**
EG for Beef Farmer	$9689.54	$9689.54	…	$9689.54	$9689.54
EG for Atlantic Community	$25739748	$25739748	…	$25739748	$25739748
Discount factor	0.926	0.857	…	0.340	0.315
EGD for Beef Farmer	$8973	$8304	…	$3294	$3052
EGD for Atlantic Community	$23835007	$22058964	…	$8751514	$8108021
EGDC for Beef Farmer	$8973	$17276	…	$79871	**$82923**
EGDC for Atlantic Community	$23835007	$45893971	…	$212172743	**$220280763**

EG = Economic Gain; **EGD** = Economic Gain Discounted; **EGAC** = Economic Gain Discounted and Cumulated

The results on the study horizon show an economic net present value of **$82 923** for an Atlantic beef farmer and **$220.28 million** for the whole Atlantic Community. The amount of $82 923 reflects the economic benefit that would be provided to an Atlantic beef farmer in a horizon of 15 years of production using the extended grazing season feeding plan. The amount of $220.28 million represents the economic benefit that would be provided to the whole Atlantic community in a horizon of 15 years of Atlantic beef producers using the extending the grazing season feeding plan. This last amount reflects the global contribution of the extended grazing season project for the economic and sustainable development of the Atlantic region. In fact, in addition to its economic benefits for beef farmers, extending the grazing season could play many other roles for the Atlantic community including recreation functions, soil erosion control, landscape maintenance and reduction of risk associated to chemical fertilizers, among others.

5.2. Summary

This chapter looked at an economic analysis of an extending the grazing season project. The quantification of costs and benefits associated with the project is done, with the conventional feeding system in the study area as the benchmark. Results show that extending the grazing season is economically beneficial for both an Atlantic beef farmer and the Atlantic region community (Figure 11).

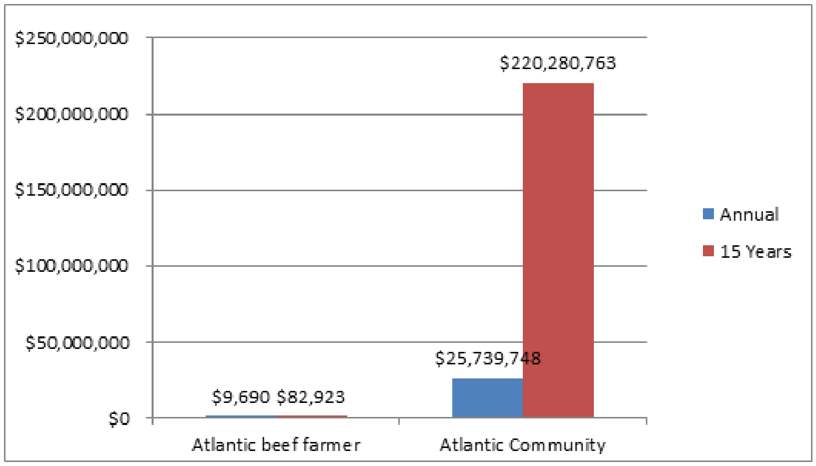


Figure 11. Economic results for an Atlantic beef farmer and for the Atlantic community

The extended grazing season project can procure an economic annual benefit of $9 689.54 to an Atlantic beef farmer and more than $25.7 million to the whole Atlantic Community. On a reasonable horizon of 15 years, the use of extending the grazing season in beef production can procure an economic benefit of $82 923 to an Atlantic beef farmer and up to $220.28 million to the whole Atlantic community.

These results reflect the necessity to support the adoption of the extended grazing season feeding plan in Atlantic beef production.

Chapter 6. Analysis of the Robustness of Project Outcomes Using Alternative Scenarios

The previous analysis, both financial and economic, was done like a case study based on the mean of farm size characteristics in the region and on all project impacts estimated. The results may not reflect the reality due to the diversity in the beef farm size and due to the importance that could be given to each project impact in the Atlantic region. For this reason, in addition to the base scenario (scenario zero) carried out above, it is proposed that new scenarios with changes on farm size characteristics and on project impacts be examined.

The financial analysis will consider changes on farm characteristics with three different scenarios: Scenario 1 reflects the small farm size in the region. Scenario 2 reflects the large farm size in the region. Scenario 3 refers to the average size farm in the region, like in the base scenario.

Scenario 1 considers a farm size of 20 cow/calf and 50 acres of farmlands, including 35 acres for pasture and 15 for hay or bale hay production. Scenario 2 considers 80 cow/calf and 200 acres of farmlands, including 120 acres for pasture and 80 acres for hay or bale hay production. Scenario 3 has the same beef farm characteristics as the base scenario; this means 40 cow/calf and 100 acres of farmlands, including 60 acres for pasture and 40 acres for hay or bale hay production. The financial analysis under scenario 3 is identical to the base scenario. Therefore, the difference between scenario 3 and the base scenario is only in terms of the economic analysis.

The economic analysis will consider only impacts which appear more realistic and relevant to the Atlantic region. This economic analysis considers project impacts by focusing on the necessity to preserve the water quality in the region and to overcome the uncertainties with weather conditions.

For the purpose of economic analysis, all direct impacts identified and estimated in the base scenario are taken into consideration under the three new scenarios. However, for the indirect impacts, only three impacts are assumed as realistic and important for an Atlantic beef farmer and or the Atlantic region. These three indirect impacts are: “reduced risk associated with chemical fertilizers”; “reduce water pollution associated with phosphorus and nitrate”; and “improve soil fertility”. Indeed, the reduction of risk associated with chemical fertilizers as well as the pollution with phosphorus and nitrate are very relevant for the Atlantic Canada region. This reduction could favorably contribute to the development of seafood production which is an important economic activity in the region. For the improvement of soil fertility, it can be noted that the improvement of soil fertility is one of the important advantages of extending the grazing season in a beef enterprise. This is possible through homogeneous distribution of manure in the field by animals themselves. Moreover, all three scenarios are supposed to be less optimistic than the base scenario under the economic analysis; the idea is to be as close to reality as possible.

6.1. Financial Analysis Under Scenarios 1 and 2

For the financial analysis under scenarios 1 and 2, parameters per cow/calf and the approach to calculations are the same as in the base scenario (section 4.2). Again, the summer grazing season is not taken into account as it does not bring any change to the analysis.

Table 18 presents the annual partial modeling of beef farm production costs under scenario 1.

Table 18 Annual Partial modeling of beef farm production costs under scenario 1

Components			**Conventional feeding plan**	**Extended grazing season feeding plan**
Herd Characteristics	Stocking rate		1.5 acres/pair	1.5 acres/pair
	Carrying capacity		1.5 acres/pair	1.5 acres/pair
	Number of cow/calf pairs		20	20
	Acres for pasture		35	35
	Acres for production of hay or baled hay		15	15
Feeding Periods	Summer pasture days		165	165
	Winter pasture days on stockpiled grazing		0	75
	Winter pasture days on bale grazing		0	125
	Total of pasture days		165	365
	Number of days in barn		200	0
	Total feeding days		365	365
Production Costs	**Stockpiled Grazing**	Pasture cost		$493.15
		Salt and Mineral		$102.74
		Yardage cost		$540.00
	Bale Grazing	Baled hay cost		$1,931.51
		Salt and Mineral		$171.23
		Yardage cost		$1,000.00
	Summer Grazing			
	Non-Grazing Season	Hay cost	$3,090.41	
		Salt and Mineral	$219.18	
		Concentrate feed	$0.00	
		Yardage cost	$3,600.00	
		Straw bedding cost	$1,103.20	
Subtotal (1) = Reduced Expenses = (a) - (b) = $3,774.16			**$8,012.79 (a)**	**$4,238.63 (b)**
Other Costs	Wind Break cost		$0.00	$30.00
	Training on management skills cost		$0.00	$40.00
	Pasture watering system		$0.00	$58.20
Subtotal (2): Additional Expenses = (d) - (c) = $128.20			**$0.00 (c)**	**$128.20 (d)**

The final result in Table 18 is the difference between Subtotal 1 and Subtotal 2. This difference corresponds to **+ $3,645.96**. The financial result under scenario 1 is positive and represents the costs saved by a small beef farm per year in Atlantic Canada through following the extended grazing season feeding plan.

Table 19 presents the annual partial modeling of beef farm production costs under scenario 2.

Table 19 Annual partial modeling of beef farm production costs under scenario 2

Components			**Conventional feeding plan**	**Extended grazing season feeding plan**
Herd Characteristics	Stocking rate		1.5 acres/pair	1.5 acres/pair
	Carrying capacity		1.5 acres/pair	1.5 acres/pair
	Number of cow/calf pairs		100	100
	Acres for pasture		120	120
	Acres for production of hay or baled hay		80	80
Feeding Periods	Summer pasture days		165	165
	Winter pasture days on stockpiled grazing		0	75
	Winter pasture days on bale grazing		0	125
	Total of pasture days		165	365
	Number of days in barn		200	0
	Total feeding days		365	365
Production Costs	**Stockpiled Grazing**	Pasture cost		$1,972.60
		Salt and Mineral		$410.96
		Yardage cost		$2,160.00
	Bale Grazing	Baled hay cost		$7,726.03
		Salt and Mineral		$684.93
		Yardage cost		$4,000.00
	Summer Grazing			
	Non-Grazing Season	Hay cost	$12,361.64	
		Salt and Mineral	$876.71	
		Concentrate feed..	$0.00	
		Yardage cost	$14,400.00	
		Straw bedding cost	$4,412.80	
Subtotal (1) = Reduced Expenses = (a) - (b) = $15,096.64			**$32,051.16 (a)**	**$16,954.52 (b)**
Other Costs	Wind Break cost		$0.00	$120.00
	Training on management skills cost		$0.00	$40.00
	Pasture watering system		$0.00	$232.80
Subtotal (2): Additional Expenses = (d) - (c) = $392.80			**$0.00 (c)**	**$392.80 (d)**

The final result in Table 19 is the difference between Subtotal 1 and Subtotal 2. This difference corresponds to **+ $14,703.84**. The financial result under scenario 2 is positive and represents the costs saved by a large beef farm per year in Atlantic Canada through following an extended grazing season feeding plan.

6.2. Economic Analysis Under the Three Scenarios

In this section, the economic analysis is done based on the selected impacts considered for the new scenarios.

6.2.1. Quantification of Costs and Benefits

The estimation of the impacts considered under the three scenarios is done based on the approach of estimation presented above in the base scenario (section 5.1.5). The estimation of benefits and costs under the three scenarios tries not to be too optimistic. Given the hypotheses above regarding project impacts, all indirect intangible impacts are not considered under the new scenarios.

6.2.1.1. Estimation of Direct Tangible Benefits and Costs

Table 20 presents the direct tangible benefits and costs under scenarios 1 and 2. The final results represent the financial results of annual partial modeling of beef farm production costs for each of the three new scenarios. These results correspond to **+ $3,645.96** for scenario 1; **+ $14,703.84** for scenario 2; and **+ $7,331.92** for scenario 3. The three amounts are positive and represent the direct tangible economic benefits that would be gained by an Atlantic beef farmer per year under the scenarios 1, 2 and 3 respectively.

Table 20 Direct tangible benefits and costs per farm and per year under scenarios 1, 2 and 3

Direct tangible benefits	**Direct tangible costs**
Reduce feed and feeding costs	Induce need of wind break
Reduce or eliminate bedding and manure management costs	Induce need of watering system
Reduce vet costs	Induce need of best management skills for farmers
	Increase animal parasitic diseases
Result Scenario 1 = + $3,645.96; Result Scenario 2 = + $14,703.84; Result Scenario 3 = + $7,331.92	

6.2.1.2. Estimation of Direct Intangible Benefits and Costs

Under scenarios 1, 2 and 3, two impacts are considered for the quantification of direct intangible impacts: "increase uncertainties on farm management with weather conditions" and "ensure soil retention and erosion control". These two impacts can be considered realistic and important for an Atlantic beef farmer and/or for the Atlantic region. In fact, soil retention and erosion control is one advantage to raising animals on field. Also, uncertainties on farm management with weather conditions represent one important reason which prevents Atlantic beef farmers from feeding their animals on field during winter.

Based on the estimation approach developed under the base scenario, the estimated costs and benefits of the two impacts considered under the three scenarios are presented in Table 21. The three values are negatives and reflect the direct intangible economic cost per farm and per year that could be associated with extending the grazing season under the three scenarios respectively.

Table 21 Direct intangible benefits and costs per farm and per year under scenarios 1, 2 and 3

Direct intangible benefits	Sc1	Sc2	Sc3	Direct intangible costs	Sc1	Sc2	Sc2
Ensure soil retention and erosion control	$89.77	$359	$179.54	Increase uncertainties on farm management with weather conditions	$287.2	$1148.8	$574.4
Total Benefits	$89.77	$359		**Total Costs**	$287.2	$1148.8	$574.4
Result Scenario 1 = - $197.43; **Result Scenario 2 = -$789.8**; **Result Scenario 3 = - $394.86**							

6.2.1.3. Estimation of Indirect Tangible Benefits and Costs

Under scenarios 1, 2 and 3, the following impacts are considered for the quantification of indirect tangible impacts: “reduce risk associated with chemical fertilizers”; “reduce water pollution associated with phosphorus and nitrate” and “improve soil fertility”.

In the base scenario, the estimation of the benefit generated by the reduction of risk associated with chemical fertilizers was done through value transfer from Ontario, Canada. As this value was the economic value procured to an Ontarian household per year through the reduction of risk associated with chemical fertilizers, it is assumed that it doesn't depend on the farm size characteristics. So, for all three scenarios, the procured amount of $252.05 is considered per farm per year.

Regarding the reduction of water pollution associated with phosphorus and nitrate: The reduction of water pollution by phosphorus was estimated using the benefit procured per household per year through reduction of 40% of its contribution to water pollution. This benefit is assumed to be the same amount calculated in the base scenario ($187.70) for all three new scenarios, independent of the farm size characteristics. Also, for the nitrate, it is assumed, under the three scenarios, that there is the same willingness to pay for the reduction of its contribution to water pollution ($240.63), independent of the farm size characteristics.

For "improve of soil fertility", the same hypothesis in the base scenario leads to the amounts of +$902.561, +$4813.66 and +$2406.83 for scenarios 1, 2 and 3 respectively.

The three final results are positives and reflect the indirect tangible economic benefits that would be gained by a beef farmer per year under the three scenarios respectively. The results of these estimations of indirect tangible benefits and costs are presented in Table 22.

Table 22 Indirect tangible benefits and costs per farm and per year under scenarios 1, 2 and 3

Indirect tangible benefits	**Sc1**	**Sc2**	**Sc3**	**Indirect tangible costs**	**Sc1**	**Sc2**	**Sc3**
Reduce risk associated to chemical fertilizers	$252,05	$252,05	$252,05	-	-	-	-
Reduce water pollution associated to phosphorus and nitrate	$428.33	$428.33	$428.33	-	-	-	-
Improve soil fertility	+$902.561	+$4813.66	$2406.83	-	-	-	-
Total Benefits	+$1582.94	+$5494	$3087.21	**Total Costs**	**$0**	$0	
Scenario 1 = +$1582.94;		**Scenario 2 = +$5494**;		**Scenario 3 = $3087.21**			

6.2.2. Annual Economic Result per Stakeholder Under the Three Scenarios

6.2.2.1. Annual Economic Result for an Atlantic Beef Farmer

In order to determine the annual economic result per Atlantic beef farmer under the three scenarios, only the costs and benefits quantified above, which directly affect beef farmers are considered. Therefore, the following elements are considered: the final result for each scenario in Table 20; the cost associated with the increasing of uncertainties on farm management with weather conditions presented in Table 21, for each scenario; and the benefit associated with the improvement of soil fertility presented in Table 22, for each scenario. The calculations lead to the economic results presented in the Figure 12.

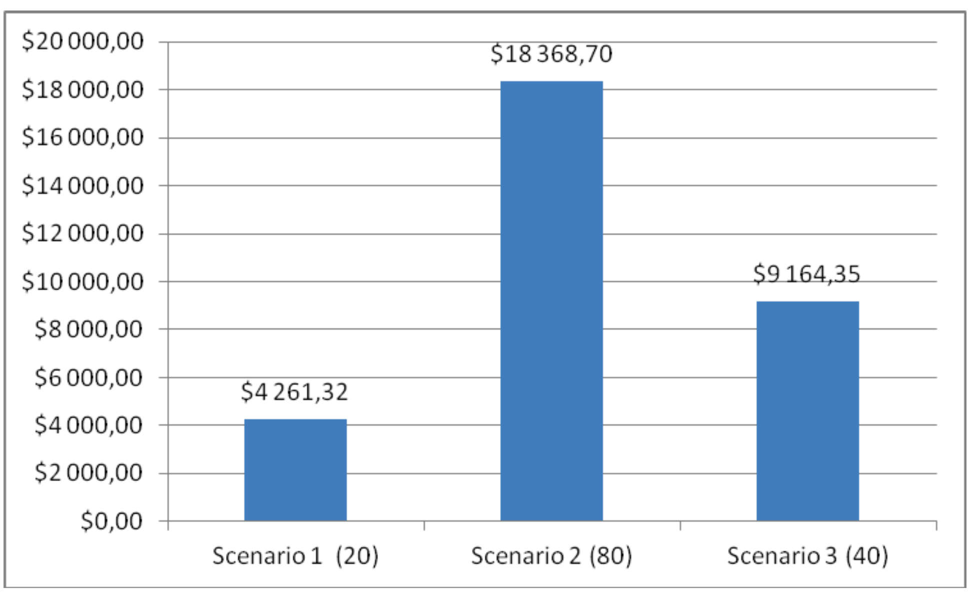


Figure 12. Annual economic results for an Atlantic beef farmer under three scenarios

These results show that extending the grazing season could be economically beneficial to all Atlantic beef farms (from small to large farm size); even with less optimistic hypothesis. The large beef farms could get more benefit from the extended grazing season feeding plan than small beef farms (Figure 12).

6.2.2.2. Annual Economic Result for the Atlantic Canada Community

To determine the annual economic result for the Atlantic community, the sum of all final results for each scenario from Tables 20 to 22 is multiplied with the number of Atlantic beef farms (1080 in 2011). The results are presented in Figure 13.

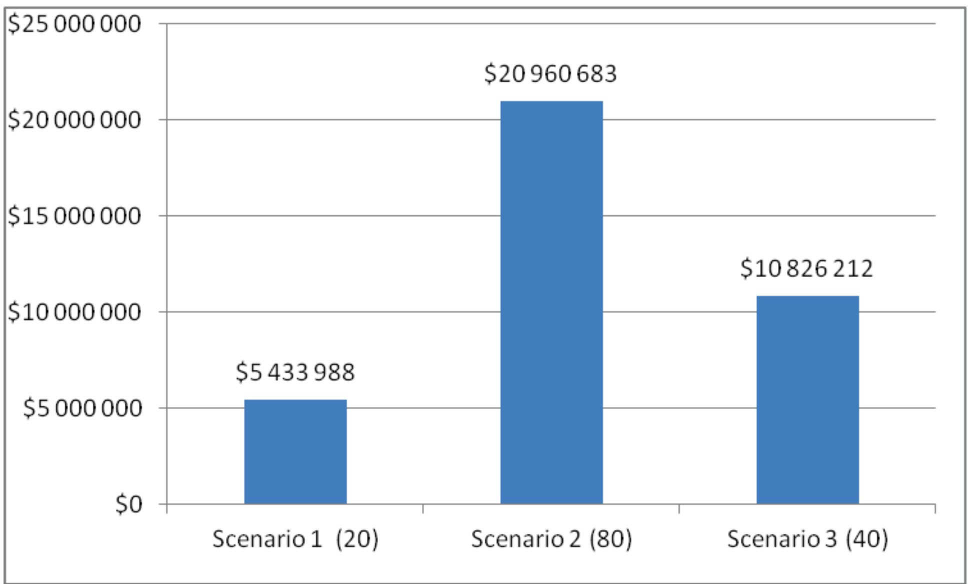


Figure 13. Annual economic results for the Atlantic community under three scenarios

The Atlantic community economic results under the three scenarios are all positive. These economic results reflect the possible contribution of the extended grazing season project for the economic and sustainable development of the Atlantic region. From small to large beef farms, there is an opportunity to adopt the extended grazing season feeding plan in the production system. Large farms offer more economic benefit from extending the grazing season than small farms (Figure 13).

6.2.3. Economic Results on the Study Horizon Under the Three Scenarios

Here we determine the economic results of the project on a study horizon of 15 years for each of the three scenarios.

For scenario 1, which represents the small beef farm size in the region, the economic analysis on a horizon of 15 years of production using extending the grazing season shows a considerable gain, for both an Atlantic beef farmer and the whole Atlantic community. On this horizon, a small Atlantic beef farm would gain $36468, while the whole Atlantic Canada would gain up to $46.5 million (Table 23).

Table 23 Economic results of the extended grazing season project: Scenario 1

years	**1**	**2**	**…**	**14**	**15**
EG for Farmer	$4261.321	$4261.321	…	$4261.321	$4261.321
EG for Atlantic Community	$5433987.6	$5433987.6	…	$5433987.6	$5433987.6
Discount factor	0.926	0.857	…	0.340	0.315
EGD for Farmer	$3946	$3652	…	$1449	$1342
EGD for Atlantic Community	$5031873	$4656927	…	$1847556	$1711706
EGDC for Farmer	$3946	$7598	…	$35126	**$36468**
EGDC for Atlantic Community	$5031873	$9688800	…	$44792360	**$46504066**

EG = Economic Gain; **EGD** = Economic Gain Discounted; **EGAC** = Economic Gain Discounted and Cumulated

For scenario 2, which represents the large beef farm size in the region, the economic analysis on the horizon of 15 years of production using extending the grazing season shows a gain of $157,199 for an Atlantic beef farmer and up to $179.38 million for the whole Atlantic community (Table 24).

Table 24 Economic results of the extended grazing season project: Scenario 2

years	1	2		14	15
EG for Farmer	$18368.7	$18368.7	…	$18368.7	$18368.7
EG for Atlantic Community	$20960683	$20960683	…	$20960683	$20960683.2
Discount factor	0.926	0.857	..	0.340	0.315
EGD for Farmer	$17009	$15742	…	$6245	$5786
EGD for Atlantic Community	$19409593	$17963306	…	$7126632	$6602615
EGDC for Farmer	$17009	$32751	…	$151413	**$157199**
EGDC for Atlantic Community	$19409593	$37372898	…	$172778912	**$179381527**

EG = Economic Gain; **EGD** = Economic Gain Discounted; **EGAC** = Economic Gain Discounted and Cumulated

For scenario 3, which represents the average beef farm size in the region, the economic results on the study horizon of 15 years of production using extending the grazing season shows a gain of $78 429 for an Atlantic beef farmer and up to $92.65 million for the whole Atlantic community (Table 25).

Table 25 Economic results of the extended grazing season project: Scenario 3

years	1	2	…	14	15
EG for Farmer	$9164.35	$9164.35	…	$9164.35	$9164.35
EG for Atlantic Community	$10826212	$10826212	…	$10826212	$10826211.6
Discount factor	0.926	0.857	…	0.340	0.315
EGD for Farmer	8486	7854	…	3116	2887
EGD for Atlantic Community	$10025072	$9278063	…	$3680912	$3410257
EGDC for Farmer	$8486	$16340	…	$75542	**$78429**
EGDC for Atlantic Community	$10025072	$19303135	…	$89240462	**$92650719**

EG = Economic Gain; **EGD** = Economic Gain Discounted; **EGAC** = Economic Gain Discounted and Cumulated

6.3. Summary

In order to analyze the robustness of the extending the grazing season project under different situations, three scenarios have been considered in addition to the base scenario (scenario zero). The three scenarios show that extending the grazing is financially and economically beneficial for both an Atlantic beef farmer and the whole Atlantic community. All Atlantic beef farmers, independently of the farm size characteristics, should have an interest in adopting the extended grazing season feeding plan in their production system. The large beef farms could get more financial and economic benefits from the extended grazing season feeding plan than small farms. The adoption of this feeding plan can contribute to the economic development of beef production in the Atlantic region. Furthermore, it could also contribute to the sustainable development of the region through environmental protection, mainly in terms of reduction of water pollution which could constrain the survival of aquatic species, which are important economic activities in the region.

Chapter 7. Summary of Findings and Conclusions

7.1. Summary of Major Results

The study aimed to integrate economic, forage agronomy and livestock production data to determine the economic costs and benefits of management techniques that can extend the grazing season for Atlantic beef production. Some major results are highlighted here, according to the study objectives.

1) The appropriate approaches for extending the grazing season in Atlantic beef production are identified under the first study objective. Indeed, the literature review on extended grazing season approaches in Canada associated with the unique weather conditions in the study area show that extending the grazing season could be well done in Atlantic Canada through the combined use of stockpiled grazing and bale grazing. Therefore, the following schema is proposed as a method for extending of the grazing season in Atlantic beef production (Figure 14).

Figure 14. Schema for extending the grazing season in beef production in Atlantic Canada

2) As a second objective of the study, the common beef feeding system in Atlantic Canada is identified and described. The common Atlantic beef feeding system is essentially based on pasture and hay. Only a few producers use the concentrate feed in their production system. During summer, which usually goes from mid-May

to end October, animals are extensively grazing unimproved pasture. The rest of the year, animals are in the barn and being fed hay forage. The main type of beef production is the cow/calf production with around 40 head and 100 acres of farmland. The stocking rate is 1.5 acres per cow/calf pair.

3) The achievement of the first and second objectives of the research study leads to the last research objective. This objective is devoted to the economic analysis of the extended grazing season project in Atlantic Canada. The purpose was to identify the most financially and economically efficient beef feeding system for an Atlantic beef farmer and for the whole Atlantic community. The financial efficiency reflects the capacity of a system to allow outputs at low costs, while the economic efficiency reflects the capacity of a system to allow more benefits than costs to a group of stakeholders and/or to a community.

The financial result, based on the mean farm size in the region, shows that extending the grazing season can contribute to avoiding an expense of $7,331.92 per farm per year. A detailed analysis shows a savings of $0.92 of the overwintering production costs per cow/calf per day. This means that, as the number of cattle days on pasture increases, the greater the reduction of production costs will be. Figure 15 summarizes the financial results of the project under three scenarios, including the base scenario. Scenario 3 has the same characteristics as the base scenario in term of financial analysis.

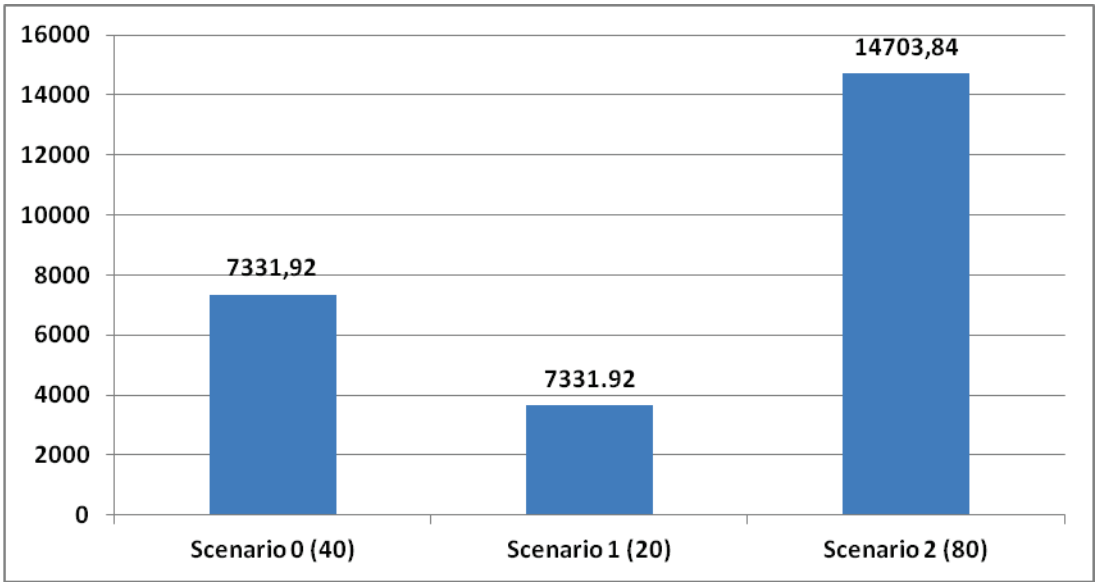


Figure 15. Annual financial results for an Atlantic beef farmer under three scenarios

The different scenarios demonstrate the financial benefit that extending the grazing season would bring to an Atlantic beef farmer through avoiding expenses associated with feed, yardage and straw bedding. Larger farms stand to benefit the most from the avoided expenses.

The economic results, based on the mean farm size in the region, show an annual benefit of $9,690 for an Atlantic beef farmer and up to $25.73 million for the whole Atlantic community. On a study horizon of 15 years, the extended grazing season project can procure an economic benefit of $82,923 for an Atlantic beef farmer and up to $220.28 million for the whole Atlantic community.

Considering the variability of beef farm sizes in the region and the realistic importance of the project impacts to the regional context, the economic results are calculated under different scenarios. These economic results, calculated for an

Atlantic beef farmer and for the Atlantic Community are presented in Figures 16 and 17 respectively.

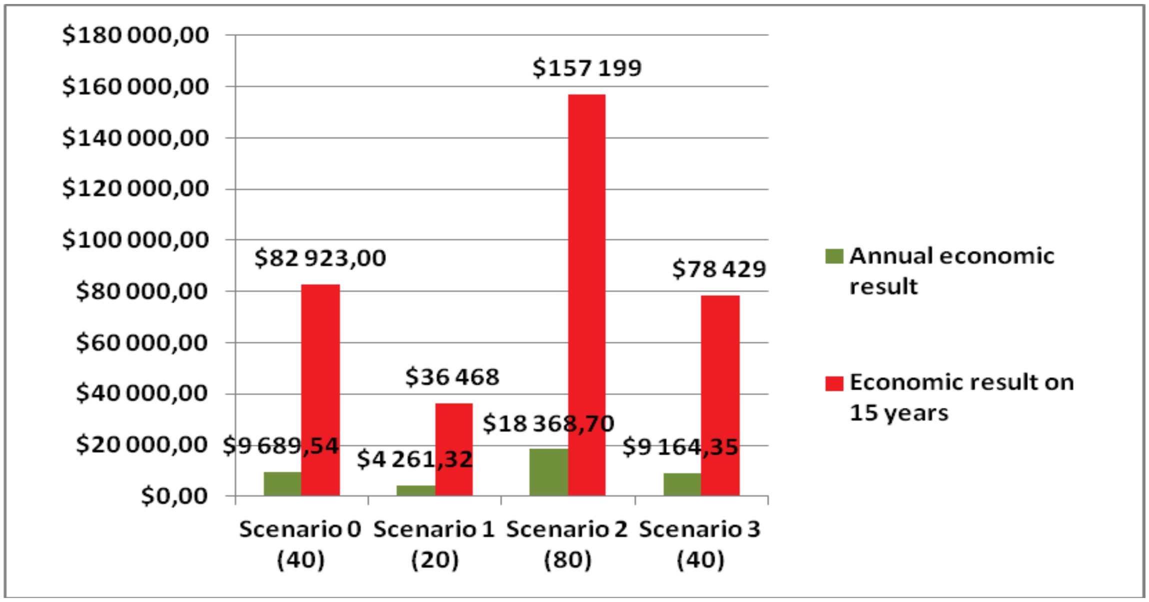


Figure 16. Annual and 15 years' economic results for an Atlantic beef farmer under four scenarios

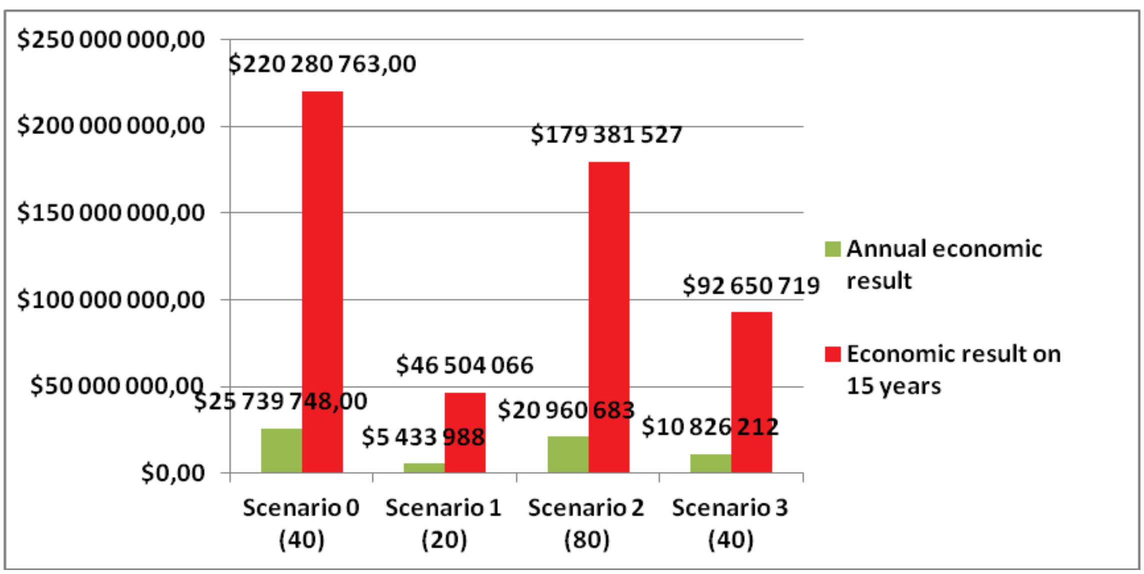


Figure 17. Annual and 15 years' economic results for Atlantic Community under four scenarios

The results from four scenarios show that, whatever the variability on farm size characteristics and the possibility to focus only on the most realistic and important impacts, the extended grazing season feeding plan is economically the most efficient feeding plan for an Atlantic beef farmer and for the whole Atlantic region.

These results reflect the necessity to encourage and support the adoption of extending the grazing season for Atlantic beef production. Furthermore, the body weight gain and body condition scores also show that beef cattle are able to maintain good performance under extended grazing season practices in Atlantic Canada. Extending the grazing season could be an alternative solution to enhance the financial and economic viability of Atlantic beef farms.

7.2. Conclusions

The study involved the integration of economic, forage agronomy and livestock production data to determine the economic costs and benefits of management techniques that can extend the grazing season for Atlantic beef production. The purpose was to determine, in comparison to the conventional feeding system, the financial and economic value of the extended grazing season project for an Atlantic beef farmer and for the whole Atlantic region.

The financial and economic results of the study show that extending the grazing season is of benefit to both an Atlantic beef farmer and the Atlantic community. By extending the grazing season, an Atlantic beef farmer can avoid expenses in the range of $3,646 to $14,704 per year depending of his farm size. These expenses are avoided through eliminating and/or reducing overwintering costs for feed, yardage and straw bedding. By taking into account its direct and indirect advantages for beef farmers, the extended grazing season feeding plan can procure an annual economic benefit in the range of $4,261 to $18,369 for an Atlantic beef farmer depending of his farm size. This annual benefit ranges between $5.43 million to $20.96 million for the whole Atlantic region. On a horizon of production of 15 years, an Atlantic beef farmer would gain a total amount in range of $36,468 to $157,199 depending of his farm size. This gain on study horizon would range between $46.5 million to $179.38 million for the whole Atlantic region community.

In summary, the extended grazing season feeding plan is financially and economically beneficial for both an Atlantic beef farmer and the whole Atlantic community. This feeding plan could be an alternative solution for enhanced beef farm financial and economic viability in Atlantic Canada and more globally in the North America. Most of all, extending the grazing season could also contribute for the sustainable development of the Atlantic region through its environmental benefits such as recreation functions, soil erosion control, landscape maintenance and reduction of risk associated to chemical fertilizers, etc.

There is a need for forage and beef cattle production specialists to support and promote the adoption of techniques to extend the grazing season in beef cattle production in Atlantic Canada. This support and promotion could involve awareness, training on grazing management skills, workshops and participatory research.

7.3. Limitations of the Study

This study has two main limitations. The first is the availability of data and the second is regarding the research methodology.

As only a very few producers practice extended grazing season approaches in Atlantic Canada, available data on this approach was limited. Also, in general, data availability for on farm production costs was limited in Atlantic Provinces. Therefore, for the modeling of farm production costs, some data were captured from Western Canada. This could cause some limits on the results of the study as Western and Atlantic regions do not typically have the same farm production costs. To overcome this situation in the future, Atlantic Provinces should emphasize applied research in beef enterprises, including data collection on production costs.

The second limit is concerning the cost-benefit analysis used for the study. Indeed, despite all its advantages, this approach presents some limits. The main limit of the approach concerns the principle of giving monetary value to all goods and services, which is not always possible (Dupuis, 1985). Also, in its application, the approach tries to quantify all direct and indirect costs and benefits of the new project. This may also present some limits as it is not evident to identify all indirect costs and benefits associated to the new project. Furthermore, it often involves a border issue, namely until what border the effects of the new project should be considered (Dupuis, 1985). However, these limits do not put into question the choice of this approach given all of the comparative advantages mentioned.

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Appendix

Appendix A: Cost Analysis of Grazing Alternatives Compared to 200 Day Winter Feeding System

System	Total Cost per Cow per Day	Yardage Cost per Cow per day	% Savings*	Savings per day	Savings per cow
Traditional Feeding (Hay/Straw)	$1.75	$0.87-$0.94			
Straw/Chaff Buncher	$0.72 or less	$0.32	59	$1.03	$206
Swath Grazing	~$0.91	$0.19	48	$0.84	$168
Stockpiled Grazing	$1.02 or less	$0.36	42	$0.73	$146
Bale Grazing	$1.35	$0.40	23	$0.40	$80

Source: Havens et al., 2006

* savings reported as compared to Traditional Feeding

Source. Saskatchewan Forage Council (2011)

Appendix B: Beef performances under bale grazing in Atlantic Canada

First Grazing Period					Second Grazing Period					Third Grazing Period				
	BCS		BW gain in Lbs			BCS		BW gain in Lbs			BCS		BW gain in Lbs	
Beef#	11-Dec-13	24-Feb-14	11-Dec-13	24-Feb-14	Beef#	16-Dec-14	09-Mar-15	16-Dec-14	09-Mar-15	Beef#	29-Dec-15	08-Mar-16	29-Dec-15	08-Mar-16
46M	5.5	5	1425	1405	59R	7	6	1400	1425	15T	7	7.5	1565	1580
18N	5.5	5	1540	1585	51S	6.5	6	1475	1445	28T	6.5	6.5	1500	1590
22R	6.5	5.5	1550	1530	6T	7	7	1750	1795	5U	7.5	7	1690	1600
45R	7	6.5	1805	1815	8T	6	5	1575	1590	8U	7	7.5	1575	1610
59R	6	5	1410	1365	5U	7	7	1710	1670	23U	7	7.5	1425	1555
51S	6	5.5	1490	1450	8U	7.5	7	1605	1645	26U	7	7.5	1800	1865
6T	7	6.5	1760	1760	23U	7	6.5	1535	1600	57U	8	8	1680	1650
8T	5.5	5	1505	1495	26U	7	7	1950	1960	60U	6	6.5	1390	1500
28T	6.5	6	1580	1635	60U	5.5	6	1435	1495	10W	5.5	6	1350	1400
5U	7	6	1690	1625	64U	7.5	6	1895	1910	16W	6.5	6.5	1695	1700
8U	6	5	1650	1585	16W	6.5	7	1745	1815	29W	7	7.5	1630	1765
23U	7	7	1515	1560	29W	6.5	7	1825	1835	52W	8	8	1795	1820
26U	7	6.5	1885	1890	31W	7.5	7.5	1840	1875	5X	7.5	7.5	1870	1850
57U	7	6.5	1745	1750	32W	8	8	1885	1860	8X	7	7.5	1570	1630
60U	5.5	5	1440	1445	2X	6.5	7	1825	1845	31X	6.5	7	1620	1740
64U	7	7	1865	1855	5X	7.5	7.5	1895	1910	34X	8	8.5	1885	1940
29W	7	7	1735	1795	8X	6.5	6.5	1630	1675	64X	6	8.5	1560	1650
31W	7.5	7	1705	1725	31X	7	7	1700	1760	16Y	5	5.5	1235	1325
33W	6	5	1575	1590	34X	7	6	1825	1855	26Y	6.5	6.5	1560	1615
43W	7.5	7.5	1555	1565	38X	6	6	1655	1695	37Y	5	6	1405	1530
48W	8	7.5	1770	1775	88X	5.5	6	1300	1300	39Y	7	7	1445	1410
52W	7.5	7.5	1770	1795	4Y	6	6	1575	1610	54Y	7.5	7.5	1875	1865
5X	7.5	6.5	1785	1735	8Y	5.5	5	1445	1460	16Z	5	5.5	1250	1300
8X	6	5	1460	1465	27Y	6	5	1470	1515	28Z	7	7	1525	1585
11X	7.5	7	1780	1765	39Y	6.5	6	1475	1465	33Z	6.5	6.5	1450	1520
31X	5.5	5.5	1630	1690	54Y	6	6.5	1680	1710	34Z	5	5.5	1310	1345
64X	5.5	5	1545	1550	32N	6.5	7.5	1590	1625	35Z	5.5	6	1290	1330
6N	5.5	5.5	1560	1630	21R	7.5	7.5	1610	1715	26R	5.5	5.5	1490	1505
32N	8	7.5	1690	1680	26R	6	6.5	1545	1620	21S	6.5	6.5	1590	1630
26R	6	6	1590	1615	45R	5	6.5	1715	1800	36S	6	6.5	1495	1500
21R	7	6.5	1595	1615	21S	6	6.5	1685	1725	44S	7	6.5	1410	1415
21S	7	6.5	1660	1660	36S	6.5	6.5	1595	1595	19T	7	7	1685	1655
52S	7.5	6.5	1560	1515	44S	6	6.5	1435	1435	47T	7.5	7.5	1655	1725
36S	6.5	5.5	1555	1550	10T	4.5	5	1535	1585	10U	8	8	1735	1775
44S	6	6	1340	1390	12T	5.5	5.5	1460	1580	51U	7	6.5	1565	1510
38T	5	4.5	1540	1555	15T	6	6	1585	1675	52U	7	7	1375	1395
10T	6.5	6.5	1760	1810	19T	6	6	1605	1620	3W	7.5	7.5	1650	1660

15T	6.5	5.5	1580	1625	28T	6.5	7	1575	1645	9W	6	6	1590	1555
19T	7	6.5	1595	1625	47T	7	7	1665	1725	11W	8	8	1855	1830
39T	5.5	5.5	1485	1455	1U	7.5	5.5	1535	1595	31W	8	8	1770	1740
47T	7	7	1730	1705	10U	7	7.5	1690	1785	4X	7.5	7.5	1750	1820
1U	5.5	5	1560	1570	51U	7	7	1645	1710	11X	6	6	1685	1630
10U	7.5	7	1780	1770	52U	7	7	1430	1505	38X	7	7.5	1670	1735
51U	7	6.5	1725	1725	57U	7.5	7	1695	1760	78X	6	6.5	1470	1540
52U	7	7	1430	1485	63U	6	7	1780	1820	4Y	6.5	6.5	1650	1630
63U	6.5	6.5	1785	1765	3W	7.5	7	1640	1715	12Y	5.5	5.5	1535	1545
3W	7	6.5	1610	1620	9W	5.5	5.5	1610	1640	22Y	7	7.5	1565	1600
9W	6	6	1600	1655	10W	5.5	6	1410	1460	36Y	6.5	6.5	1420	1385
10W	7.5	7	1455	1485	11W	7.5	7.5	1855	1930	52Y	6	7	1235	1555
16W	6.5	6	1700	1695	4X	6.5	6.5	1730	1805	84Y	6	6	1385	1415
2X	6	6	1650	1665	11X	6.5	5.5	1610	1680	92Y	7	7	1565	1580
4X	7	6.5	1680	1715	64X	6	6.5	1495	1625	2Z	6	6.5	1275	1320
10X	6.5	5.5	1660	1635	78X	5.5	5.5	1475	1520	18Z	5.5	5.5	1490	1500
11X	6	6	1560	1495	12Y	5.5	5	1480	1540	19Z	6.5	6.5	1455	1460
34X	5	4.5	1540	1580	26Y	5.5	5	1440	1525	26Z	6.5	6.5	1480	1495
38X	65.5	5.5	1490	1525	36Y	6.5	6	1385	1410	25Z	5.5	5.5	1290	1330
78X	5	5	1325	1395	37Y	6	5	1360	1440	36Z	5.5	5.5	1275	1310
88X	5	5	1275	1255	88Y	6	6	1390	1490	41Z	6.5	6.5	1305	1295
4Y	6.5	5.5	1555	1505	84Y	6	4.5	1360	1365	53Z	6	6	1330	1365
8Y	5	5	1335	1365	92Y	7	6	1495	1540					
12Y	5	4	1345	1375	19Z	5.5	4.5	1405	1475					
15Y	5	5	1285	1305										
22Y	6	5.5	1495	1515										
26Y	5	4.5	1360	1380										
27Y	5.5	5	1355	1395										
37Y	5.5	5	1295	1315										
39Y	5	5	1330	1310										
54Y	6	5	1480	1480										

Beef# = Beef identification; BCS = Body Condition Scores; BW = body weight in Lbs (pounds)

Appendix C: Synthesis of studies on the assessment of environmental costs

Type d'aménités	Étude	Description de l'étude	Résultats	Lieu géographique
Études globales	USEPA [2002a]	Évaluation des bénéfices sociaux d'une nouvelle réglementation sur les élevages intensifs.	Les bénéfices estimés sont équivalents aux coûts estimés.	Etats-Unis
	Landry et Levallois [2000]	Recueil de diverses études évaluant entre autres la perception de la population face aux nuisances environnementales et les déterminants de dépenses de protection face à la baisse de la qualité de l'eau. Méthodes et approches utilisées : mise en relation diverse de questionnaires, systèmes d'information géographique, régressions économétriques, statistiques, analyses politiques, etc.	Multiples et très diversifiés.	Régions de Portneuf, Lanaudière, Nicolet-Yamaska et Île d'Orléans, au Québec
	Pillet *et al.* [2000]	Évaluation de la durabilité de l'agriculture suisse par l'estimation des externalités économiques.	> Transfert de bénéfices, méthode *ad hoc*. Bénéfices estimés dépassent les coûts à partir de 2003.	Suisse
Qualité de l'eau	Eisen-Hecht et Kramer [2002]	*CAP* pour conserver la qualité de l'eau par le moyen d'implantation de pratiques agroenvironnementales (*Best management practice*, BMPs) Revenu moyen par ménage : 55 481$ et taux de réponse au sondage : 47 %.	> Évaluation contingente 139 $US/ménage/an	Bassin versant de la rivière Catawba en Caroline du Nord
	Loomis *et al.* [2000]	Estimation des avantages pour 5 services des écosystèmes : dilution des eaux usées, contrôle de l'érosion, habitat pour les poissons et vie sauvage et activités récréatives. Entrevue auprès de 100 personnes	> Évaluation contingente 252 $US/ménage/an	South Platte river, Denver, Colorado
	Mathews *et al.* [2002]	Estimation des avantages pour l'amélioration de la qualité de l'eau (réduction de 40% de la pollution associée au phosphore). Répondants : âge moyen 50 ans, 70% homme. Taux de réponse au sondage : 44.2% Revenu moyen par ménage : 49 615$. Description de la région : 1 million de ménages	> Évaluation contingente 140 $US/ménage/an	Rivière Minnesota, État du Minnesota
	Morgan et Owens [2001]	Estimation des avantages monétaires de la réglementation pour l'amélioration de la qualité de l'eau visant surtout la diminution du phosphore, le *Clean Water Act*. Les avantages estimés sont supérieurs aux coûts.	> Transfert de bénéfices 358M à 1,8MM$US pour une partie de la population du Maryland et de la Virginie.	Chesapeake Bay
	Van Kooten *et al.* [1998]	*CAP* pour diminution du taux de nitrates dans les eaux de la région par le compostage d'une partie ou de la totalité des déjections animales. Dans l'échantillon, près de 60% étaient peu familiers avec les effets des nitrates dans l'eau, plus de 60% trouvaient que les odeurs et autres nuisances des fermes étaient une nuisance, près de 60% trouvaient que la qualité de l'eau de leur région était inadéquate et plus de 70% voulaient que le gouvernement impose une réglementation sévère sur l'usage de fertilisants et la manutention des déjections animales.	> Évaluation contingente 135–210 $CAN/ménage/an	Région d'Abbotsford, Colombie-Britannique
	Yadav et Wall [1998]	Estimation des avantages de la restauration de la qualité de l'eau souterraine. Utilisation de la méthode des coûts évités : traitement de l'eau, achat de l'eau embouteillée, forage de nouveaux puits.	> Méthode des coûts évités 40-330 $US/ménage/an	Minnesota Garvin Brook watershed
Risque associé aux pesticides	Brethour et Weersink [2001]	Bénéfice perçu par la diminution de l'utilisation de pesticides constatée entre 1983 et1998 en Ontario. L'index du risque dépend des matières actives et des quantités utilisées.	> Évaluation contingente et statistiques ontariennes 188$US/ménage/an	Ontario
Valeur des propriétés	Leggett et Bockstael [2000]	Estimation des effets de la qualité de l'eau sur les valeurs des propriétés. Indicateur : coliformes fécaux. Données utilisées : vente de propriétés riveraines entre 1993 et 1997	> Prix hédoniques Changement de 100 CF/100ml accompagne une variation de 1.5 % du prix	Chesapeake Bay, Maryland
Valeur des propriétés	Palmquist *et al.* [1997]	Effet de la quantité de lisiers porcins produits à faible distance sur le prix des maisons. Concentration importante en 1993 : entre 43 et 490 porcs/km² selon le comté et grande concentration (95% des porcs produits par 13% des 8500 fermes ayant des porcs en inventaire). Données utilisées : 237 ventes de maison en 1992-93. Contexte technologique et agronomique de l'étude dépassé par rapport à celui du Québec.	> Prix hédoniques Impact négatif (entre 0 et 9 % de la valeur d'une maison de 73 000$US) de la qté de lisiers produits à moins de 3 km des maisons. Varie surtout avec la qté de lisiers produits, la distance et la concentration existante.	État de la Caroline du Nord, Centre-Est des Etats-Unis
Écosystèmes	Turner *et al.* [1988]	Estimation de la valeur non-marchande d'écosystèmes de la Georgie et comparaison avec leur valeur totale (marchande + non-marchande)	> Évaluation contingente <u>Champs</u> : 887$US/ha/an, dont 12% non-marchand <u>Marécages</u> : total = 889$/ha/an, dont 100% non-marchand <u>Forêts</u> : total = 654$/ha/an, dont 31% non-marchand	État de la Georgie, Sud-Est des Etats-Unis
Paysages	Drake [1999; 1992]	*CAP* pour la préservation du paysage agricole (contexte d'homogénéisation du paysage semblable à celui du Québec). Préférence marquée de la population vers une plus grande diversité et une plus grande variabilité du paysage. La principale motivation à payer vient de la préservation de la nature (69% de l'échantillon).	> Évaluation contingente 470 à 700 SEK/pers/an. Note : Ce montant, converti à 970 SEK/ha cultivé/an, donne une valeur supérieure à la valeur privée nette des terres agricoles. 1SEK90=0,17$CAN90.	Suède
	Hackl et Pruckner [1997]	*CAP* de touristes pour financer des programmes ciblant les agriculteurs et visant à améliorer les paysages (valeur non-marchande des paysages agricoles auprès des touristes). Échantillon : 4000 touristes locaux ou internationaux à l'été 1991. Contexte paysager autrichien éloigné de celui du Québec. Territoire occupé à 80% par l'agriculture ou la forêt.	> Évaluation contingente 6 à 12 ATS/pers/jour de visite selon l'origine et la région visitée (moyenne=9,20, médiane=3,5, écart-type=15,95ATS91. Note: 1ATS = 0,1$CAN	Autriche
PIB ajusté	Pretty *et al.* [2001]	Ajustement de la part du PIB de l'agriculture moderne par ses externalités, qui correspondent essentiellement aux bénéfices environnementaux et aux dommages causés aux actifs naturels (eau, air, sol, paysages, santé humaine). Les auteurs disent sous-estimer les dommages en général.	Dépréciation du PIB agricole de la Grande-Bretagne, de l'Allemagne, des États-Unis.	Royaume-Uni, Allemagne et Etats-Unis
Caractéristiques de la demande	Höckby et Söderqvist [2001]	Estimation des caractéristiques économiques de la demande pour un bien environnemental, soit la diminution de l'eutrophisation de la Mer Baltique par la diminution de l'apport d'azote à partir de cinq études d'évaluation contingente suédoises.	Élasticité-revenu du *CAP* < -1 ; Élasticité-revenu de la demande = 0,7 à 1,5 ; Élasticité-prix de la demande = 1,8 à 2,4.	Mer Baltique, Suède
Caractéristiques de l'offre	Bonnieux *et al.* [1998]	Étude de déterminants de l'adhésion de producteurs français à des programmes agro-environnementaux.	> Régression économétrique Plusieurs déterminants significatifs (âge, scolarité, méthodes culturales, etc.)	Basse-Normandie, France

CAP = consentement à payer

Source. Debailleul *et al.* (2003)

Appendix D: Per-hectare ecosystem service value estimates cross-tabulated by land cover and service type

CATEGORY	Recreation	Aesthetic/ amenity	Other cultural	Pollination & dispersal	Habitat refugium/ biodiversity	Atmospheric regulation	Soil retention erosion control	Water quality/ nutrient & waste regulation	Water supply/ regulation	Disturbance avoidance	TOTAL
Agriculture											
Agriculture	$137		$97	$28		$31					$291
Grassland/Pasture/Hayfield	$53		$134	$19	$95	$19	$4	$25		$5	$353
Forest											
Forest: Non-urban	$270		$240		$2,428	$992		$513			$4,443
Forest: Urban	$14,903		$249	$7,536		$992		$513	$1,649		$25,843
Forest: Suburban	$11,373		$249			$992		$513	$1,649		$14,777
Forest: Adjacent to stream	$559				$133	$992	$779	$621	$1,320	$148	$4,552
Forest: Hedgerow			$7	$25		$992					$1,023
Urban herbaceous											
Urban herbaceous greenspace		$43,539	$249								$43,788
Open water											
Open water: River	$8,655		$25		$10			$33,906	$12,957		$55,553
Open water: Urban/suburban river	$172,691	$242						$45,768	$17,690		$236,392
Open water: Inland lake	$3,820	$593	$25					$612			$5,050
Open water: Great Lake nearshore	$554	$240									$795
Open water: Estuary/tidal bay	$451	$1,289			$13			$54	$45		$1,852
Wetlands											
Wetlands: Non-urban, non-coastal	$3,551	$6,446	$2,286		$75	$14		$2,779			$15,171
Wetlands: Urban/suburban	$9.861	$129				$14		$3,168	$48,929	$99,318	$161,420
Wetlands: Great Lakes coastal	$590	$2,527	$8,970			$14		$2.660			$14,761
Beach											
Beach: general	$72,892	$1,386								$15,330	$89,608
Beach: Near structures	$96,635	$2,773								$30,660	$130,068
Beach: Not near structures	$49,150										$49,150

Source. Troy and Bagstad (2009)